EVALUATION OF PERI-IMPLANT SOFT & HARD TISSUE RESPONSE AFTER SINGLE TOOTH REPLACEMENT WITH PLATFORM SWITCHED IMPLANT: A CLINICO-RADIOGRAPHIC STUDY

A Dissertation submitted in partial fulfillment of the

requirements for the degree of

MASTER OF DENTAL SURGERY

BRANCH – II

PERIODONTOLOGY

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

CHENNAI – 600032

2016-2019

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"Evaluation of peri-implant soft & hard tissue response after single tooth replacement with platform switched implant: a clinico-radiographic study"** is a bonafide and genuine research work carried out by me under the guidance of **Dr.C.S.PRABHAHAR, M.D.S., Professor, Head of the Department,** Department of Periodontology, Best Dental Science College, Madurai – 625104.

Dr. V.BENEDICT

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This is to Certify that **Dr.V.BENEDICT,** Post Graduate student (2016 – 2019) in the Department Of Periodontology, Best Dental Science College, Madurai – 625104 has done this dissertation titled **"Evaluation of peri-implant soft & hard tissue response after single tooth replacement with platform switched implant: a clinico-radiographic study"** under my direct guidance and supervision in partial fulfillment of the regulations laid down by the Tamil Nadu Dr.M.G.R Medical University Chennai – 600032, for M.D.S. Department Of Periodontology (Branch II) Degree Examination.

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In all your ways acknowledge Him, And He will make your paths straight.

- Proverbs 3:6

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CERTIFICATE II

This is to certify that this dissertation work titled **EVALUATION OF PERI-IMPLANT SOFT & HARD TISSUE RESPONSE AFTER SINGLE TOOTH REPLACEMENT WITH PLATFORM SWITCHED IMPLANT: A CLINICO-RADIOGRAPHIC STUDY** of the candidate **Dr.V. BENEDICT** with registration Number 241613401 for the award of **Masters of Dental Surgery** in the branch of Periodontology. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows 12% percentage of plagiarism in the dissertation.

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PLACE OF STUDY	BEST DENTAL SCIENCE COLLEGE, MADURAI – 625104.
DURATION OF THE COURSE	3YEARS
NAME OF THE GUIDE	Dr. C.S.PRABHAHAR, M.D.S
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This agreement herein after the "Agreement" is entered into on this day Dec 2018, between the Best Dental Science College represented by its **Principal** having address at Best Dental Science College, Madurai – 625104, (hereafter referred to as, 'the College')

And

Mr.Dr.C.S.PRABHAHAR, M.D.S., aged 45 years working as **Professor and HOD** in Department of Periodontology at the College, having residence address at 9/3 Vallalar Street, Alagappapuram, Karaikudi – 630 002, Sivagangai district.

(herein after referred to as the 'Principal Investigator')

And

Mr. Dr.V.BENEDICT aged 39 years currently studying as **Post Graduate student** in Department of Periodontology, Best Dental College, Madurai- 625104 (herein after referred to as the 'PG/Research student and co-investigator')

Whereas the PG/Research student as part of his curriculum undertakes to research on **"EVALUATION OF PERI-IMPLANT SOFT & HARD TISSUE RESPONSE AFTER SINGLE TOOTH REPLACEMENT WITH PLATFORM SWITCHED IMPLANT: A CLINICO-RADIOGRAPHIC STUDY"** for which purpose PG/Principal Investigator shall act as Principal Investigator and the college shall provide the requisite infrastructure based on availability and also provide facility to the PG/Research student as to the extent possible as a Co-investigator.

Whereas the parties, by this agreement have mutually agreed to the various issues including in particular the copyright and confidentiality issues that arise in this regard.

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In witness whereof the parties hereinabove mentioned have on this day, month and year herein above mentioned set their hands to this agreement in the presence of the following two witnesses.

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PG Student

Witnesses

1. DR. VIJAY. K.K. M.D.S., PROFESSOR

2. DR. M.UMAYAL, MDS, Senior Lecturer

Student Guide

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LIST OF ABBREVIATIONS USED

AB	**Alumina oxide Blasted**
AE	Acid Etched Surface
ANSYS	Analysis System
BBL	Buccal Bone Level
BII	Bone Implant Interface
BOP	Bleeding on probing
CBCT	Cone Beam Computed Tomography
CT	Computed Tomography
DBL	Distal Bone Level
Di	Bone level on the implant side
Dt	Bone level on the tooth side
FEA	Finite Element Analysis
FP	Fixed Prosthesis
HCl	Hydro Chloric acid
IAJ	Implant Abutment Junction
IS	Implant Survival
ISQ	Implant Stability Quotient
JE	Junctional Epithelium
KT	Keratinized Tissue
LBL	Lingual Bone Level
MBL	Mesial Bone Level, Marginal Bone Level

MPa	Mega Pascal
MPo	Myelo Peroxidase
MT	Mucosal Thickness
MM	Mobility Measuring Device
Ncm	Newton centimeter
NO	Nitric Oxide
PD	Probing Depth
PH	Papilla Height
PISF	Peri Implant Sulcus Fluid
PRISMA	Preferred Reporting Items for Systematic reviews and Meta Analysis
PS	Platform Switched implant
RA	Regular platform and Angulated abutment
RCT	Randomized Controlled Trial
REC	Buccal peri-implant mucosal level
RP	Removable Prosthesis
RVG	Radio Visuo Graphy
SA	Platform Switching and Angulated abutment
SBI	Sulcus Bleeding Index
SD	Standard Deviation
SP	Standard Platform implants
T1DM	Type I Diabetes Mellitus
T2DM	Type II Diabetes Mellitus

UNC 15	University of North Carolina number 15
VHG	Vertical Height of jumping distance

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INTRODUCTION

Replacement of missing tooth and lost tissues is an integral part of dentistry. Over the years replacement of teeth were carried out using either a removable or a fixed dental prosthesis. Although these replacements were satisfactory in most of the cases, patient's compliance was found to be less particularly in long span edentulous and completely edentulous patients. Dentists put forth considerable clinical skills in an effort to cope with the consequences of partial and/or complete edentulism[1,2]. Unfortunately under the conventional partial or complete dentures, the residual alveolar ridge resorption is unavoidable[3]. Dental implant emerged as an alternative option after the accidental observation of integration of titanium screws into bone was observed by **Bothe et al** in 1940 and later described by **Gottlieb Leventhal** in 1951. The use of osseointegrated endosseous implant to support the fixed or removable prosthetic treatment have residual alveolar bone preservation[3].

The reactions described by **Leventhal and Bothe et al**. were later coined into the term "osseointegration" by **Per-Ingvar Branemark**[4]. Osseointegration is defined as direct bone anchorage to an implant body, which provides support for a prosthesis; it allows the transmission of occlusal forces directly to the bone[5]. In 1952, **Per-Ingvar Branemark** of Sweden conducted an experiment where he utilized a titanium implant chamber to study the blood flow in rabbit bone. At the conclusion of the experiment, when it became time to remove the titanium chambers from the bone, he discovered that the bone had integrated so completely with the implant that the chamber could not be removed. **Branemark** called this "osseointegration", and, like **Bothe et al**. and **Leventhal** before him, saw the possibilities for human use. In dentistry, the implementation of osseointegration started in the mid-1960s as a result of **Branemark's** work[6].

The **Branemark** osseointegrated screw, has been universally accepted as a recognized treatment for edentulous jaws[1]. Dental implants from then on have made a huge change in treatment modalities in dentistry.

Osseointegrated dental implants have offered additional treatment options for edentulous and partially edentulous patients[7]. Implant is a biocompatible alloplastic material or device that is surgically placed into orofacial tissues and used for anchorage, functional, therapeutic, and/or esthetic purposes[8].

Primary implant stability plays main role in the success of implants which depends on biocompatibility of the implant material, macroscopic and microscopic nature of the implant surface, the status of the implant bed in both health and morphologic context, the surgical technique, the health of the person receiving the treatment, gender, occlusion and the health of the tissues in the mouth, jaw type the subsequent prosthetic design and long-term loading phase[1,5,9,10,11]. Length and diameter of the implant and quantity and quality of bone are also found to play an important role in the success of implant therapy[10,12,13].

Replacement of a single missing tooth with an implant -supported crown is a conservative approach than preparing two adjacent teeth for a tooth supported fixed partial denture[6]. Since the introduction of dental implants for the replacement of missing teeth, various modifications in implant designs & surgical techniques have been developed to improve the prognosis of the implant supported prosthesis. Bone remodeling occurs during the first year in response to occlusal forces and establishment of normal dimensions of the peri- implant soft tissues. Thus an implant with marked bone loss may be judged as surviving rather than successful [14,15].

Crestal bone loss has been documented as one of the important factors that affect the long term prognosis of an implant and its success. The use of a smaller diameter abutment on a larger diameter implant collar, is believed to shift the Implant Abutment Junction (IAJ) horizontally inward. This phenomenon is called platform switching[16,17].

Excessive dynamic loading leads to stress/strain concentrations which induce marginal bone loss[18,19].The biomechanical theory proposed that connecting the implant to a smaller-diameter abutment may limit bone resorption by shifting the stress-concentration zone away from the crestal bone–implant interface and directing the forces of occlusal loading along the axis of the implant[20]. The physical repositioning of the IAJ away from the external outer edge of the implant and neighboring bone forms microgap which limit bone resorption by containing the inflammatory cell infiltrate within the angle formed at the interface away from the adjacent crestal bone [8,18]. In this way peri-implant bone will be shielded from the inflammatory connective tissue infiltrate which further reduces crestal bone resorption [17,21].

Soft tissue around natural teeth consists of approximately 1mm of connective tissue, 1mm of epithelium[22]. This natural seal is also present around implants, and its development is the major cause of bone resorption after implant exposure leading to formation of supra crestal attached tissues (biological width) [21,23,24].The average biological width around the implant is 3mm that consist of JE (1.8mm) which is longer than natural teeth JE and 1.05mm connective tissue component[25].There should be attached keratinized mucosa on the palatal and buccal aspect around all implants. It forms a strong seal around the implant with a cuff of circular fibres[26].

In a two-stage surgical approach, the delayed formation of the biological width is observed following exposure of an implant unlike crestal-bone remodelling which begins immediately in single stage implant [17,27].

Bone resorption of 1.5- 2.0mm may occur at the implant- abutment junction after second stage surgery[16,28]. A vertical bone loss ranging from 0.9 -1.6mm in the first year and mean annual crestal bone loss ranging from 0.05-0.13mm in the maintenance period implies that it shows successful implant osseointegration[1,29,30,32].

Platform switching also provides the clinician with additional surgical and prosthetic treatment options for use with wide-diameter implants. Moreover, the implant design modifications involved in platform switching offer multiple advantages and potential applications.

The primary criterion for defining a successful implant is the crestal bone level around dental implant following restoration[31]. The bone levels are usually more or less stable, but small changes such as 0.2 mm per annum are impossible to measure with conventional radiographs[14].Hence there arises a need for CBCT.

CBCT scanning has opened up new dimension to dentistry in the aspect of diagnosis, treatment planning, surgical preparation and execution, follow-up, and management of complications[33]. Traditional dental imaging techniques provide diagnosis related to implant planning only partially. The marginal bone on the buccal and the lingual/palatal surface of implant, the proximity of the implant to the buccal and lingual/palatal plates and possible perforation of the plates cannot be assessed with periapical radiographs. Though CT provides the same with accuracy, the radiation exposure to the patient is comparatively high. The drawbacks of these modalities were improved with the introduction of Cone Beam Computed Tomography(CBCT) for imaging orofacial structures. Upon acquiring the image, CBCT manufacturers use advanced mathematical algorithms so that as the data are projected in screen they are already corrected for magnification. The measurements provided are very precise for most CBCT scanners in the market[34,35].

Although there are numerous studies to support the concept of platform switching, we require further study to thoroughly elucidate the benefits it provide in random Indian population who are known for reduced quantity and quality of bone. Hence there is a need for this study.

AIM & OBJECTIVES

AIM:

The purpose of this study is to clinically evaluate the peri-implant soft tissue health and hard tissue response by CBCT after single tooth replacement with platform switched implants for a period of 1 year at regular 3 months time interval.

OBJECTIVES OF THE STUDY:

- To clinically evaluate the peri-implant soft tissue health (Gingival Index, Plaque Index, Sulcus Bleeding Index ,keratinized mucosa thickness) before and after placement of implant and prosthesis at regular 3 months interval.
- To clinically evaluate Probing Depth, around implant after placing prosthesis at regular 3 months time interval.
- To radiographically evaluate the peri-implant crestal bone alteration by taking CBCT immediately after implant placement, after prosthesis and 12 months after implant placement.

REVIEW OF LITERATURE

Surgical cobalt-chromium-molybdenum alloy was introduced in 1938 by **Strock** (Boston, MA) when he replaced a single maxillary left incisor tooth with a root form, l-piece implant that lasted more than 15 years. In 1946, **Strock** designed the first titanium, 2-piece screw implant that was initially inserted without the permucosal post[36].

The success of implant depends on the connection of bone to implant surface which is known as "Osseointegration", a term coined by **Branemark** in 1952. Achieving proper osseointegration is the main goal to have proper anchorage under normal loading conditions. The osseointegration depends on some factors such as its surface characteristics, its design, coating of the surface, technique of placement, laser treatment of implant surface, bone source to augment the socket to have a proper primary stability, otherwise it may negatively influence the osseointegration by formation of fibrous tissue at the bone implant interface leading to bone resorption[36].

Classification of Implants:

Dental implants may be classified under four categories

A - Depending on the placement within the tissues

B - Depending on the materials used

C - Depending on their reaction with bone

D - Depending on the treatment options [37].

Misch bone density classification:

Misch described four bone densities found in the anterior and posterior edentulous regions of the maxilla and mandible.

Bone density can be determined by tomographic radiographs, especially CT(computer tomography). Each CT axial image has 260,000 pixels, and each pixel has a CT number (Hounsfield unit) related to the density of the tissues within the pixel. In general, the higher the CT number, the denser the tissue.

- **D1** bone is primarily dense cortical bone (> 1250 Hounsfield units)
- **D2** bone has dense to thick porous cortical bone on the crest and coarse trabecular bone underneath (850-1250 Hounsfield units)
- **D3** bone has a thinner porous cortical crest and fine trabecular bone within (: 350--850 Hounsfield units)
- **D4** bone has almost no crestal cortical bone (150--350 Hounsfield units)
- **D5**: <150 Hounsfield units[36]

Components of dental implants:

The most common root form design has a separate abutment and implant body, They are most often connected together with an abutment screw.

PLATFORM SWITCHED IMPLANTS

Platform switching is a current concept in implant dentistry which was introduced by **Richard J Lazzara, Stephen S. Porter** in 2006 to minimize crestal bone loss around implants[17]. In platform switched implants, the diameter of the abutment is smaller than the implant collar diameter which increases the distance between the implant – abutment interface, in association with inflammatory cell infiltrate and the marginal bone, which obviously leads to decrease in the crestal bone resorption[38]. The increasing degree of mismatch between the implant body and the abutment makes more favourable marginal bone level around implants[39]. The success of implant is assessed by crestal bone level changes from baseline to the period of study. In two piece implant system, bone remodeling takes place from uncovering of submerged implant both horizontally and vertically at the crestal margin and biologic width was re-established. Biological width plays a major role in esthetics and health of implants[40].

N. Enkling et al (2006) aimed to evaluate the crestal bone level changes on platform switched implants after 3 years whereas most of the studies were limited to 12 months. He conducted a 3 year randomized clinical trial with 25 patients. Two implants with a diameter of 4 mm were inserted crestally in the posterior mandible. The intraindividual allocation of platform switched (3.3 mm platform) and standard implant (4mm platform) was randomized. Single tooth crown was cemented after 3 months of submerged healing. Patients were monitored at short intervals for healing and oral hygiene. Brunner – langer model was employed for the statistical analysis of bone levels. The mean radiographic peri – implant bone loss was 0.69 ± 43mm (platform switching) and 0.74 ± 0.57 mm (standard platform) at the end of 3 years. The mean intraindividual difference was 0.05 ± 0.58 mm. The crestal bone level alterations depended on time (p <0.001) regardless of platform type (p= 0.363). This three year randomized clinical trial using identical implants with different platforms limited vertical bone loss regardless of platform type. Thus, the hypothesis of a bone resorption preventing effect of platform switching could not be confirmed[41].

Capiello et al (2008) aimed on clinical and radiographic examination of two piece implants that were restored according to platform – switching protocol. This prospective study evaluated the bone loss around implants. A total of 131 implants were placed in 45 patients requiring oral rehabilitation, following a non-submerged surgical protocol. 75 test implants, with a healing abutment 1mm narrower than the implant platform were placed at the time of surgery. A healing abutment of the same diameter as the implant were inserted in the remaining control implants. All implants were positioned at the crestal level. Clinical and radiographic examination were performed prior to surgery, at the end of surgery, 8 weeks after placing implants, at the time of provisional prosthesis insertion, at the time of definitive prosthesis insertion and 12 months after loading. The collected data showed that vertical bone for the test cases varied between

0.6mm and 1.2mm (mean 0.95 ± 0.32mm), while for the control cases, bone loss was between 1.3mm and 2.1mm (mean 1.67 ± 0.37mm). Thus the data confirmed that the use of a narrower abutment increased the distance between the implant – abutment microgap and the crestal bone reducing bone resorption. Thus, platform switching seems to reduce peri-implant crestal bone resorption and increase the long-term predictability of implant therapy[23].

Luigi Cannullo et al (2008) aimed to evaluate the soft tissue response on post-extraction immediately restored implants using platform switching concept. 22 patients were included in the study. 22 implants of 5.5mm platform diameter were placed immediately into fresh extraction sockets in maxillae without compromised bone tissue. The Post-extraction bone defects were filled eventually with bovine bone matrix mixed with collagen. Implants were randomly divided into two groups. 11 implants were connected with 3.8mm diameter abutment (test group) and remaining 11 implants were connected with 5.5mm diameter abutment (control group). A provisional crown with non-functional immediate positioning was adapted. Definitive prostheses were placed after two months. Periodontal parameter, buccal peri-implant mucosal changes (REC), mesial and distal papilla height (PH) and vertical height of jumping distance (VHG) were measured at the time of implant placement, after definitive prosthesis insertion and every 6 months thereafter. All implants were clinically osseointegrated. The mean follow up was 25 months. The test group showed a +0.18mm REC gain. The mean values were statistically significant ($P \leq 0.005$) compared with the control group. (PH = -0.88mm; REC = -0.45mm). Periodontal parameters showed on difference between the two groups. The mean value of bone filling was 7.51mm in the test group (97.4% of VHG) and 8.57mm in the control group (95.2% of VHG). There was no statistically significant difference between the two groups. This study suggested that, in a limited time period of 2 years, immediately placed platform switched implants can provide peri-implant tissue stability[42].

Roberto Lungo et al (2008) conducted a study to examine biopsy specimens to explain the biologic processes occuring around a platform switched implant. A 65 year old women presented to the university to obtain a prosthesis supported by three implants (Prevail, 3i/Implant innovations) that had previously been inserted in a dental office. The implants had been placed before 2 months in a one-step surgical procedure. They featured a full osseotite surface and were 10mm long with an extended platform of 4.8mm, body of 4mm and an internal attachment of 4.1mm in diameter. The transition from the extended part measuring 4.8mm to the 4.1mm attachment was fabricated with a 16 degree chamfer about 0.35mm long. The implants were placed in the anterior mandible to support removable overdenture. The implant was perfectly integrated both clinically and radiographically. With the patient's consent, it was decided to remove the implant because of prosthetic rehabilitation difficulties. After removal, the implant was sectioned and subjected to histologic and histomorphometric analysis. An inflammatory connective tissue infiltrate was localized over the entire surface of the implant platform and approximately 0.35mm coronal to the implant-abutment junction along the healing abutment. Platform switching appeared to be a valid method of reducing crestal bone loss. The biological processes responsible for this occurrence seem to be linked to distancing of the inflammatory connective tissue infiltrate from the alveolar crest. This in turn results from a more inward displacement of the microgap on the implant platform switching enables preservation of peri-implant hard and soft tissue over time[43].

Paolo vigolo et al (2008) conducted a 5 year study to clinically assess and compare crestal bone changes around platform switched restorations on wider diameter implants. They included 5mm diameter implant with an external hexagon in patients from the year 2000 to 2002 in a private office. 182 implants were placed in 144 patients. They were placed in posterior areas of the jaws. 85 implants restored with matching wide-diameter prosthetic components were scheduled under Group A and the 97 implants restored with platform switched prosthetic components were under Group B. All implants survived. Marginal bone resorption was measured using intra-oral radiographs each year after abutment and crown insertion. Statistically significant difference was observed after 1year. The mean marginal bone resorption was 0.9mm (SD= 0.3mm) for GROUP A implants and 0.6 mm (SD= O.2 mm) for Group B implants after 1 year. There was no significant change in marginal bone resorption at the second, third, fourth and fifth year of follow up[20].

Jason Schrotenboer et al (2008) studied the effect of microthreads and platform switching on crestal bone stress levels. Two-dimensional finite elemant imaging was used. Cross sectional model of an implant with 5mm platform and 13mm length placed in premolar region of the mandible was created with finite imaging. The test models consisted of microthreads at the crestal portion and the control model consisted of smooth neck. The implant model was reverse engineered to resemble a commercially available microthread implant. A force of 100N at 90° vertical and 15° oblique angles were created over abutments of different diameters (4.0mm: 20% platform switching; 4.5mm: 10% platform switching; 5.0mm: standard) upon loading, the microthread implant model had 29% greater stress (31.61MPa in oblique and 9.31MPa in vertical) than the smooth neck implant (24.51 and 7.20MPa, respectively) at the crestal bone adjacent to the implant. The microthread model and smooth neck model showed reduced stress at the crestal level, when the abutment diameter decreased from 5.0 to 4.0mm. They concluded that microthreads increased crestal stress upon loading. Less stress were translated to the microthread and smooth neck group implants by using platform switched technique[44].

Luigi cannullo et al (2009) did randomized controlled trial to evaluate marginal bone level alterations at implants restored with platform-switching concept, using different implant/abutment mismatching. 80 implants were randomly placed in the posterior maxilla of 31 patients. They were divided into four groups according to platform diameter 3.8mm (control), 4.3 (test group 1), 4.8mm (test group 2) and 5.5mm (test group 3). After 3 months, implants were connected to 3.8mm diameter abutment and final restorations was performed. Radiographic bone height was measured by two independent examiners at the time of implant placement (baseline) and after 9, 15, 21 and 33 months. After 21 months, all implants were clinically osseointegrated. 69 implants were taken into analysis, as 11 implants had to be excluded due to early unintentional coverscrew exposure. Radiographic examination showed a mean bone loss of 0.99m (SD = 0.42mm) for test Group 1, 0.82mm (SD = 0.36mm) for test Group 2, 0.56 (SD = 0.31mm) for test Group 3. These values were statistically lower when compared with control group (1.49mm, SD = 0.54mm). Remaining 60 implants were evaluated after 33 months because five patients were lost during follow-up. This data showed no difference compared with 21 months data except for test Group 2 (0.87mm) and test Group 3 (0.64mm). There was an inverse correlation between the extent of mismatching and amount of bone loss. This study suggested that marginal bone level alterations could be related to extent of implant/abutment mismatching. Marginal bone levels were better maintained with implants restored with platform-switching concept[26].

Roberto crespi et al (2009) conducted a study to assess marginal bone around platform switched implants and conventional implants after 24 months. A total of 45 patients were selected and divided into two groups. The first group comprised of 34 implants placed with external hexagon junction with the abutment and the second group of 34 implants placed with platform switched abutments. All implants were positioned immediately after tooth extraction and were loaded immediately. After 24 months, a cumulative survival rate of 100% was reported for all implants. The platform switched showed a mean bone loss of 0.78 ± 0.49mm and the conventional group showed a mean bone loss of 0.73 ± 0.52mm . There was no statistically significant difference between the groups. They concluded that no differences were found in bone level after 24 months between platform switched and conventional implants used in an immediate loading protocol[45].

Roberto cocchetto et al (2009) aimed at a study to evaluate the hard tissue response around wider platform-switched implants. The study aimed to examine whether shifting the microgap further inward by increasing the discrepancy between the abutment diameter and implant platform would result in a reduced crestal bone loss. 10 patients requiring mandibular or maxillary implant restorations and having alveolar crest thickness of atleast 8.0mm at the implant placement site were included in the study. Fifteen certain PREVAIL implants with a body diameter of 5.0mm, an expanded platform feature with maximum diameter of 5.8mm at the collar and a prosthetic seating surface of 5.0mm were used. The lengths used were 8.5, 10.0, 11.5 or 13.0mm. The healing abutment of 4.1mm were connected in a single stage protocol. Periapical radiographs taken before and immediately after surgery, 8 weeks after implant placement, immediately after definitive prosthesis insertion and at 12 and 18 months after loading, revealed an average peri-implant bone loss of 0.3mm. The results of the study showed that patients receiving wide platform-switched implants may experience less crestal bone loss than the use of regular platform switching or traditional non-platform switched implants[31].

Jui-Ting Hsu et al (2009) did an experimental and three dimensional finite analyses to estimate the bone strain and micromovement at the bone-implant interface (BII) for platform switching and different diameters of single, immediately loaded mandibular implant. Four models were created and implants assembled were 5mm in diameter with abutments of 5 or 4mm in diameter on bonded (delayed-loading treatment) and contact (immediate-loading treatment) BIIs. Also a model with an implant diameter of 3.75mm was also analyzed. Vertical and lateral loads of 130N were applied to all models. Using experimental testing and Finite Element

Analysis (FEA), bone strains were found higher in immediately loaded implants than in delayed-loaded implants. Platform switching slightly reduces strain (<10%) in crestal bone. However, bone strain decreases on increasing the implant diameter in immediately and delayed loaded implants. Micromotion at BII does not differ between implants with and without platform switching[46].

Hee-Jun kwon (2009) aimed to study the influence of tooth and implant-side marginal bone level on the interproximal papilla dimension in a single implant with a microthread, conical seal and platform-switched design implant. 17 patients were treated with single implants. Periapical radiographs were taken. The bone levels on the implant (Di) and tooth sides (Dt) were recorded. The dimension of the papilla (Ph) was measured as the shortest distance from the top of the papilla to the crestal bone. The marginal bone levels of the implants were also measured. The pearson correlation coefficient was used to correlate the variables. Regression analysis was used to determine whether Di or Dt had a significant ($P<0.05$) influence on ph. The result showed that there is positive correlation between Ph and Di ($r = 0.413$; $p = 0.023$) and between Ph and Dt ($r = 0.830$; $p<0.0001$). However, only Dt had a significant influence on Ph. They finally concluded that Dt is the dominant factor that influences the interproximal soft tissue dimension between a natural tooth and a single implant with a micro-thread, conical seal and platform-switched design[47].

Atieh MA and Ibrahim HM et al (2010) aimed at systemic review and meta-analysis of marginal bone preservation around platform switched implants. A literature search of electronic databases was performed up to March 15, 2010. 10 studies with 1,239 implants were included. The review and meta analysis were done according to the guidelines of PRISMA. The marginal bone loss around platform switched implants was significantly less than around platform matched implants. No implant failures were detected between the two groups. Subgroup analyses presented that an implant-abutment diameter difference > or = 0.4 was associated with a more favourable bone response. They concluded that platform switching may preserve inter implant bone height and soft tissue levels. The degree of marginal bone resorption is inversely related to the extent of the implant-abutment mismatch. However, further studies are needed to confirm this concept[48].

Tomas Linkevicius et al (2010) studied about the influence of thin mucosal tissues on crestal bone stability around platform switched implants. The study included 4 patients with twelve two-piece implants. Among 12 implants, 6 were traditional matching implants and 6 were platform switched implants. The mean age of the patients was 43 years (range 37 to 56 years). Mucosal tissue thickness was measured to be 2mm or less at implant sites. Implants were restored with 5 splinted crowns and single 3-unit fixed partial denture after 2 months of healing. Intra-oral radiographs were taken at implant placement and after 1 year follow-up. The statistical significance level was set to $p < 0.05$. Bone loss around test implants was 1.81 ± 0.39mm on the mesial site and 1.70 ± 0.35mm on the distal aspect. Bone loss around control implants was 1.60 ± 0.46mm on the mesial site and 1.76 ± 0.45mm on the distal site. No statistically significant difference was found. Finally they concluded that platform switched implants did not preserve crestal bone better when compared with traditional implants, if thin mucosal tissues were present at the time of implant placement[49].

Luigi Canullo et al (2010) aimed to compare the composition of peri-implant microbiotas associated with platform switched implants and traditional implants. 48 implants placed in 18 subjects were included in the study. 33 implants were restored with platform switching and 15 implants were restored using the traditional approach. Subgingival plaque samples were taken from the mesio and disto buccal aspects of each implant and from one tooth adjacent to one of the implants in each subject. Samples were taken 36 months after prosthetic loading. Samples were individually analyzed for their content of 40 bacterial species using checkerboard DNA-DNA hybridization. Microbiologic parameters were compared between platform switching and control implant group and also between implants and teeth. There was no significant difference between groups for any of the species. The platform switched implants showed a small trend for lower levels of early colonizer members of the Actinomyces, purple and yellow complexes, campylobacter species, Trannerella forsythia (previously T. forsythensis) and Porphyromonas gingivalis. Teeth and implants presented similar microbial profiles. The study finally suggested a lack of association between peri-implant microbiota and the marginal bone loss of platform-switched or traditional implants[50].

Annibali S et al (2012) did a systemic review and meta analysis of studies comparing platform switching and conventionally restored implants. They reviewed literature to compare implant survival (IS) and marginal bone loss (MBL) around implants. They conducted the study through randomized controlled human clinical trials (RCTs) comparing IS and MBL in PS and conventionally restored implants with 12 months of follow-up. Review and meta-analysis were performed according to PRISMA statement. 10 RCTs involving 435 subjects and 993 implants contributed to this review. The cumulative estimated implant success rate revealed no significant difference between two groups. A smaller amount of MBL [MD -0.55mm, 95% CI (-0.86; -0.24), P = 0.0006] was noted around PS implants at patient level. Subgroup analyses revealed loss MBL when platform switching showed a larger mismatching at implant level. Thus, they concluded that PS technique appeared to be useful in limiting bone resorption. They suggested that further research is needed to identify the factors most associated with successful outcomes[51].

Ana paula martini et al (2013) did a 3D finite element analysis to evaluate stress distribution on peri implant bone with straight or angulated abutments on regular and platform switched implants in the anterior maxilla. Four mathematical models of central incisor were created. Models were supported by external hexagon implant (13mm × 5mm) varying platforms [R_1 regular or S_1 switching] and abutments [S_1 straight or A_1 angulated 15 º]. The models were created using Mimics 13 and solid works 2010 software programme. ANSYS workbench 10.0 was used for numerical analysis. Oblique forces (100N) were applied to the palatal surface of the Central Incisior. The bone / Implant interface was considered perfectly integrated. Minimum (σ_{min}) and maximum (σ_{max}) stress values were obtained. The highest stress values (σ_{max}) were observed in the RA [Regular Platform and Angulated abutment, 51 MPa], followed by SA (Platform switching and Angulated abutment, 44.8 MPa), RS (regular platform and straight abutment, 36.5 MPa) for cortical bone. The highest stress values (σ_{max}) were observed in the RA (6.55 MPa), followed by RS (5.88 MPa) SA (5.60 MPa) and SS (4.82 MPa). The result of the study showed that regular platform generated higher stress in the cervical peri implant region on the cortical and trabecular bone than platform switched implants, irrespective of the abutment used (straight or angulated)[52].

Georgios E Romanos et al (2014) aimed at a study to evaluate the long term success of immediately occlusal loaded implants with a progressive thread design and platform shifting in the edentulous mandible. 78 implants were connected with their abutments in 13 patients immediately after surgery. The implants were splinted using a fixed temporary restoration. The patients were advised to take soft /liquid diet for first 6 to 8 weeks of healing to reduce excessive loading in the bone-to-implant interface. Final prostheses were fabricated by taking abutment level impressions without removing abutments. Final restorations were delivered 4 to 8 weeks after surgery. They were cemented temporarily to evaluate the peri-implant soft tissue condition at different time intervals after removal of the restoration. Clinical stability and radiological indices were evaluated at the start of loading, at 3 months interval after loading and then annually. After a mean loading period of 75.29 months, no implant was lost. All clinical indices had values in normal levels. The periotest values showed continuous reduction, representing high stability. The crestal bone level was relatively stable and only minimal crestal bone loss was observed in some implants[53].

Brent A.Wenzel et al (2014) conducted a study using dog model to evaluate the effect of platform shift on crestal bone levels and mucosal profile following flap surgery and subcrestal implant placement in presence/absence of gap defects. Four dental implants were placed into the left/right edentulated posterior mandible in five adult male hound labrador mongrel dogs using flap surgery. Implants were placed subcrestally with/without a 1 X5mm (width × depth) gap defect and using platform shift/switch and standard abutments. Block biopsies were collected for histological/histometric analysis following an 8 weeks healing interval. No significant differences were observed in crestal resorption and peri-implant mucosal profile and apical extension of epithelial attachment among different groups. They concluded that clinical strategies including flap surgery and subcrestal implant placement, implant with platform switch and standard abutments, surgical approach and abutment selection seem to have limited impact on crestal remodelling, associated bone loss and mucosal profile[54].

Erhan Dursun et al (2014) did a study to compare the marginal bone level alterations, stability measures, volume of Myelo Peroxidase (MPO) and Nitric Oxide (NO) of Peri-Implant Sulcus Fluid (PISF) between Platform Switched (PS) and Standard Platform (SP) implants. 32 implants were inserted into mandibular premolar / molar regions with a single stage protocol and final restorations made after 3 months of osseointegration. Periapical radiographs were used to measure marginal bone loss. Implant stability was measured by mobility measuring device and resonance frequency analysis, PISF MPO and nitric oxide level analysis were done spectrophotometrically with the samples collected with paper strips. Peri-implant parameters were assessed by periodontal indices and all other parameters were evaluated at baseline, 1,3,6 and 12 months follow up. There was no healing problem for any implant at the end of the study period. Mean bone loss measures were 0.84 and 0.76mm, and mean Implant Stability Quotient (ISQ) values were 74.04 and 76, and mean mm values were found as -4.82 and -6.26 for PS and SP implants respectively. There were no significant differences between implant types on clinical peri-implant indices, PISF volume and laboratory measures and the study showed that platform switching seemed not to affect marginal bone level, clinical peri-implant parameters, MPO and NO (Nitric Oxide) metabolism around implants[38].

Tomas Linkevicius et al (2014) conducted a study to compare how laser-microtextured implants and platform switched implants maintain crestal bone stability in thin peri-implant tissues. 30 patients with thin mucosal tissues were included in the study. 30 laser microtextured implants of 4.6mm diameter were under Group I (Tapered, Internal laser-10K, Bio Horizons, Brimingham, AL, USA). 30 platform switched implants were under Group II (Certain Prevail; Biomet/3i, Palm Beach Gardens, FL, USA). Implants were placed in posterior mandible and restored with screw-retained metal-ceramic restorations. Radiographs were taken after implant placement, 2 months after healing, at prosthetic restoration delivery and after 1 year follow-up. Mean crestal bone loss was calculated, Mann-Whitney U-test was applied and the significance was set to 0.05. The crestal bone loss was 0.71 ± 0.25mm SD and 1.02 ± 0.25mm SD after 2 months of healing in groups 1 and 2 respectively. At restorations delivery the crestal bone loss was 1.10 ± 0.30mm SD and 1.37 ± 0.27mm SD in groups 1 and 2 respectively. The crestal bone loss was 1.41 ± 0.42mm SD and 1.43 ± 0.23mm SD in groups 1 and 2 respectively after 1 year follow up. They finally concluded that both the implant type did not eliminate crestal bone loss. However, laser-microtextured implants presented less proximal bone loss than platform switched implants in thin soft tissue type before implant loading[55].

Maarten Glibert et al (2014) conducted a study to analyze the clinical and radiographic outcome of implant with and without platform shift. 115 implants were placed in 48 consecutively treated patients. 39.1% were of diameter 5.0mm enabling platform shifting with a 4.0mm wide prosthetic component. 60.9% were of diameter 4.0mm with a 4.0mm component. Radiographic crestal bone levels and other multivariate statistical analysis were performed to evaluate crestal bone loss at baseline and 1 year. All implants survived and mean marginal bone loss was 0.73mm. There was statistically significant difference in bone loss between platform-shifted (0.63mm) and non-platform-shifted (1.02mm) implants. Both implants yielded high survival and limited crestal bone loss after 1 year of loading. Crestal bone loss was minimized using platform shifted implants placed in sufficiently voluminous bone. This study concluded that implant diameter with platform shifting can be considered to limit the crestal bone loss[56].

Tomas Linkevicius et al (2014) explained the influence of soft tissue thickness on crestal bone changes around platform switched implants. 80 patients received 80 bone-level implants of 4.1mm in diameter with platform switching. Tissue thickness was measured and the cases were distributed between Group 1 (with thin soft tissue 2mm or less, n=40) and Group 2 (with thick soft tissue more than 2mm,n=40). Implants were placed with single stage approach and restored with screw-retained restorations. Radiographic examination was performed after implant placement, 2 months after healing, after restoration and at 1 year follow up. Crestal bone loss was calculated. The Mann-Whitney U-test was performed and significance was set to $p \leq 0.05$. Implants in Group 1 (thin tissue) showed 0.79mm of bone loss after 2 months, and 1.17mm after 1 year follow up. Implants in Group 2 (thick tissue) showed bone loss of 0.17mm after 2 months and 0.21mm after 1 year follow-up. The differences were significant ($P<0.001$) between the two groups. They concluded that crestal bone level can be maintained in platform switched implants if mucosal tissue is thick and also suggested that crestal bone loss cannot be prevented if mucosal tissue is thin[57].

Mohammed D. Al Amri et al (2015) did a longitudinal study to compare the clinical and radiographic status of platform switched implants placed in patients with and without type 2 diabetes mellitus (T2DM). A total of 45 male non-smokers were included in the study. 23 patients with T2DM were under Group-I and 22 self reported non-diabetic controls were under Group-II. The platform switched implants that were used had a diameter of 3.5mm and length ranging from 10mm to 14mm (straumann Dental Implant system). All implants were placed at the level of the alveolar crest in the posterior mandible using an insertion torque of 35Ncm. Healing abutments were connected to the implants using hand torque. Peri-implant Bleeding On Probing (BOP), Probing Depth (PD), Marginal Bone Loss (MBL) and Hemoglobin A1C (HbA1C) levels were measured at 12 and 24 months of follow-up. The mean age of participants in groups 1 and 2 were 42.4 years (40-46 years) and 41.8 years (39-44 years), respectively. The mean duration of T2DM was 14.5 ± 0.7 months in Group-I. There was no significant difference in the mean HbA1C levels, peri-implant BOP, PD and MBL in both groups. The study concluded that platform-switched implants can remain clinically and radiographically stable in patients with T2DM in a manner similar to non-diabetic individuals. However, bone loss around implants is influenced by several factors (such as oral hygiene status, glycemic control and tobacco smoking) and not merely platform switching is emphasized[58].

Luigi Cannullo et al (2016) conducted a study to evaluate the 10 year post-loading radiological and esthetic outcomes of immediately loaded post extractive implants with or without platform-switching protocol. The study was conducted from September 2005 to December 2015. 22 patients for maxillary post-extraction implant were included in the study. The implant used was 13mm in length and 5.5mm in diameter (Global, Sweden & Martina, Padua, Italy). The test group received definitive restorations using platform-switching concept (abutment 3.8mm in diameter). The control group received standard restoration (abutment 5.5mm in diameter). Outcome measures were survival rates of implants and prosthesis, peri-implant marginal bone loss and periodontal indices 10 years after prosthetic loading. Also, esthetic parameters including soft tissue buccal peri-implant mucosal levels (REC) and mesial and distal papilla height (PH) were taken at definitive restoration, 2 and 10 years thereafter. Nineteen implants were analyzed after 10 years of follow-up. Neither implants nor prostheses failed. The post-operative radiographs demonstrated an overall mean bone loss of 0.18 ± 0.14mm in the test group and of 0.80 ± 0.40mm in the control group (P = 0.00108). Test group presented 0.23 ± 0.51mm of REC gain and PH was of 0.21 ± 0.3mm on average. The control group presented a REC of -0.59 ± 0.80mm with PH of -1.12 ± 0.55mm, demonstrating a slight continuous soft tissue shrinkage during the entire follow-up. The mean values were statistically significant and different between test and control group for both REC gain (P = 0.01174) and PH (P = 0.0009). This study concluded that immediate single implant restorations rehabilitated with platform switching protocol may provide peri-implant alveolar bone-level stability and avoid continuous soft tissue shrinkage after 10 years of prosthetic loading compared to a platform matching restoration. However, studies involving larger sample sizes are required to confirm these preliminary results[59].

Eisner Salamance et al (2017) conducted a study to observe the changes in vertical and horizontal marginal bone levels in platform switched and platform matched dental implants. 51 patients aged between 28 and 80 years who received 60 dental implants were included in the study of 1 year period. Dental implants were placed 6 weeks after tooth extraction. Periapical radiographs were used to measure peri-implant alveolar bone changes before and 12 months after prosthodontic restoration delivery. Measurement was performed between the implant shoulder and the most apical and horizontal marginal defect using periapical radiographs. The marginal bone measurements showed a bone gain of 0.23 ± 0.58mm in the vertical gap and 0.22 ± 0.53mm in the horizontal gap of platform matching. Platform switching showed a bone gain of 0.93 ± 1mm in the vertical gap and 0.50 ± 0.56mm in the horizontal gap was found. The average vertical gap reduction from the baseline until 12 months was 0.92 ± 1.11mm in platform switching and 0.29 ± 0.85mm in platform matching. They concluded that platform switching seemed to be more effective for a better peri-implant alveolar bone vertical and horizontal gap reduction at 1 year[60].

MATERIALS AND METHODS

STUDY PATTERN

This prospective clinical trial was conducted on 14 subjects. The study was approved by the institutional ethical committee of Best Dental Science College and Hospital, Ultra nagar, Madurai, Tamil Nadu, India (Annexure-I) and informed consent was obtained from all the participants (Annexure-II) according to WORLD MEDICAL ASSOCIATION DECLARATION OF HELSINKI[61].

SOURCE OF DATA

The study was conducted in the Department of Periodontology, Best Dental Science College & Hospital during the period November 2016 – November 2018.

SUBJECT AND SITE SELECTION

14 subjects (age group 18-60), attending the outpatient section, Department of Periodontology, Best Dental Science College & Hospital were selected for the study according to the following inclusion & exclusion criteria.

Inclusion criteria:

- Subjects with atleast one missing maxillary/mandibular posterior tooth
- Subjects should be periodontally and systemically healthy (not taking medications known to interfere with periodontal tissue health or healing)
- Subjects with stable occlusion relationship
- Presence of opposing teeth
- Subjects with sufficient bone volume for placing implants
- Subjects with no active infection at the implant site

Exclusion criteria:

- Subjects with compromised psychologic and mental conditions
- Smokers
- Subjects having parafunctional habits
- Subjects with multiple missing teeth
- Supraerupted opposing teeth
- Subjects having any systemic diseases like diabetes, hyper thyroidism / hypo thyroidism

STUDY DESIGN:

Subjects were selected according to the above mentioned inclusion and exclusion criteria. The medical and dental history was recorded. Scaling was done 1 week prior to surgery and oral hygiene instructions were given. Irreversible hydrocolloid (COLTENE COLTOPRINT chromatic alginate, manufacture by COLTENE WHALEDENT Pvt.Ltd., India) impression of the surgical site and the opposite arch were taken using standard trays. Acrylic surgical template was fabricated and used to maintain the precision of the osteotomy. Preoperative CBCT was done to estimate the bone quality and width of the bone at the alveolar crest of the edentulous area. It also measures the distance of crest from the inferior alveolar canal (width & length), Maxillary sinus and Mental foramen, so as to maintain a 2mm clearance. Accordingly the adequate size of implant was chosen.

ARMAMENTARIUM FOR SURGERY:

- Mouth mirror
- UNC -15 probe
- William's probe
- Explorer
- B.P handle no.3 and no-15 B.P blade
- Metal suction tip
- Austin’s retractor
- Straight/curved artery forceps
- Toothed tissue forceps
- Periosteal elevator
- Surgical scissors
- Needle holder
- 2ml syringe loaded with 2% lignocaine HCL with 1: 80,000 adrenaline
- NSK physiodispenser
- ADIN TOUAREG^{TM}-S implant kit
- Normal saline (NS-eurolife)
- Cotton swab and gauge
- Dappen dish
- Bite block
- Disposable gloves, face masks and head cap
- Suture material (3-0 black silk suture)
- Kidney tray with saline and irrigating syringe

ADIN IMPLANT KIT:

This kit contains all the surgical and prosthetic instruments required for placement of all designs of ADIN dental implants, that includes:

- Tip drill, Drills, Torque ratchet, Depth gauge ,Drill extender ,Implant drive,Hand hex driver and torque hex driver

Drills:

The kit contains 5 universal drills of diameters D2.0mm, D2.8mm. D3.2mm, D3.65mm and D4.2mm. All drills are having easily identifiable depth markings at 8mm, 10mm, ll.5mm, 13mm, 15mm, 16mm and 18mm.

Torque Ratchet:

The ADIN torque ratchet is an all titanium two piece construction, which makes it simple to dismantle and clean. It can be used for surgery and prosthetics with indicated torque values ranging from 0-50 Ncm. The indicated torque value for primary stabilization of implant is 35 Ncm and for tightening of screw retained prosthesis is 25Ncm.

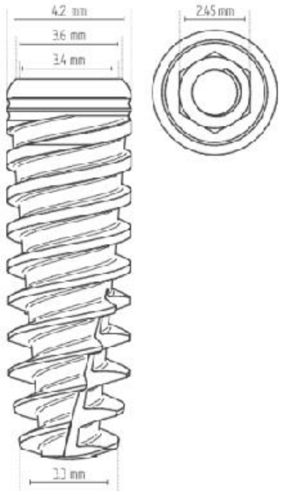
Depth Gauge:

The depth gauge is designed to fit the 2mm pilot hole as well as the 3.3mm osteotomy sites. The depth markings on the gauge correspond to the lengths of the ADIN Implants.

Hand hex Driver and Torque hex Driver:

The hand driver and torque drivers along with torque ratchet, handpiece torque drivers are used with handpiece for insertion of the Implant. Both hand and ratchet driven hex drives are used for cover screw, gingival former and abutment placement.

ADIN TOUAREG^{TM} –S IMPLANT:



The Touareg^{TM}-S spiral implants are tapered implants with a spiral tap that condenses bone during placement for enhanced immediate stability. It has two large variable threads and a tapered core for accurate implant placement, self-drilling, improved esthetics and better load distribution.

The Touareg ^{TM}-S implants features a special round shaped apex that pushes the bone graft with minimal harm to anatomic structures.AB /AE- Alumina Oxide Blasted / Acid Etched surface treatment involves blasting with sulfuric acid and hydrochloric acid to remove embedded particles. Built in platform switching specifies, the prosthetic connection of this implant system in a standard internal hex 3.5mmD for all implants regardless of the diameter.

Implants are available in four diameters D3.5mm, D3.75mm, D4.2mm D5.0mm and D6.0mm and in lengths of L6mm, L8mm, L10mm, L11.5mm, L13mm L16mm and L18mm. We used D4.2mm and L10mm,11.5mm and 13 mm for our subjects and the horizontal diameter difference between implant seating surface and the abutment is 0.7mm. The package of ADIN includes the implant fixture, cover screw. Healing abutment, impression transfer, lab analog and application specific abutment, all are coming under the same package.

Cover Screw:

At the time of insertion of a two-stage implant body, a first-stage cover screw is placed into the top of the implant to prevent bone, soft tissue, or debris from invading the abutment connection area during healing[36].

Healing Abutment / Gingival Former:

After a prescribed healing period sufficient to allow a supporting bone interface to develop, a second-stage procedure may be performed to expose the two-stage implant or to attach a transepithelial portion. This transepithelial portion is termed a "*permucosal extension*" because it extends the implant above the soft tissue and results in the development of a permucosal seal around the implant. This implant component has also been called a "*healing abutment*" because stage II uncover surgery often uses this device for initial soft tissue healing[36].

Abutment:

An abutment for screw retention uses a hygiene cover screw placed over the abutment to prevent debris and calculus from invading the internally threaded portion of the abutment retention during prosthesis fabrication between prosthetic appointments. An abutment for screw retention uses a screw to retain the prosthesis or superstructure[36].We used screw retained engaging castable abutment & prosthesis for our study.

Analog:

An analog is defined as something that is analogous or similar to something else. An implant analog is used in the fabrication of the master cast to replicate the retentive portion of the implant body or abutment. After the master impression is obtained, the corresponding analog is attached to the transfer coping and the assembly is poured in stone to fabricate the master cast[36].

NSK PHYSIODISPENSER:

It is the reliable surgical micromotor that follows exact command. Maximum output / Maximum torque is 230 W /5-80 Ncm and Maximum Pump Output is 75mL/min. The surgic NSK SG20 S-Max 20:1 non-optic implant contra angle handpiece is used for prolonged surgical procedures.

Features:

- Dual irrigation system
- 20:1 reduction
- Non-optic
- Ergonomic comfort grip

Ceramic bearings are 25% harder than conventional steel bearings but are only half the weight. Thus efficiency and durability is increased. Ergonomic design with stainless steel body gives best possible access to the operating site, excellent balance and tactile feel. The NSK Quattro water spray (M95L/M95) effectively cools the entire operating field. All programmes can be performed by hand free mode due to foot control availability. It can control some modes like speed control, coolant flow and direction of rotation. Though the speed range is 200-40,000rpm min^{-1} noise production and vibration are very less.

SURGICAL PROCEDURE:

All surgical procedures were performed by one clinician and under standard conditions. The subjects were adviced to rinse with chlorhexidine gluconate for 30 seconds immediately before the procedure. The surgical site was anesthetized using 2% Lignocaine HCL with adrenaline(LIGNOX 2%A,1: 80,000). Open flap technique was done in all cases. The osteotomy was initiated using a Tip drill through the surgical template making a punch hole.

A crestal incision was made along the crest of the ridge, bisecting the existing zone of keratinized mucosa. A periosteal elevator was used then to reflect the mucoperiosteal (full-thickness) flap both bucally and lingually to the level of mucogingival junction, exposing the alveolar ridge of the implant surgical sites. The bone at the implant site was thoroughly debrided of the granulation tissue and the knife-edge ridges if any were flattened. Sequential drilling was initiated with the pilot drill of 2mm size through the indentation on bone made by the tip drill, according to the implant size. In between guide pin was inserted to check the prepared depth and its orientation. Periapical radiographs with guide pin were taken in between to analyse the relationship to neighboring vital structures.

The final osteotomy diameter of the implant determines the final drill used. For D2 bone the width of the final drill used is one size lesser than the actual width of the implant. For D3 bone the number of steps of drilling and time of preparation are reduced because the less dense D3 bone easily expands and often permits larger - diameter implants to be inserted.

After the final drilling the implant was inserted with the help of an insertion tool and a torque ratchet. Minimum 35 to 40 Ncm of torque was achieved to ensure primary stability. After complete insertion of the implant into the bone, cover screw placed and the surgical site was thoroughly irrigated with sterile saline. Proper closure of flaps were achieved by suturing, with 3-0 black silk suture.

Subjects were prescribed antibiotics (amoxicillin 500 mg+clavulanic acid 125mg thrice daily), analgesics (aceclofenac 100mg+paracetamol 500mg twice daily) and antacid (pantaprazole 40mg twice daily) for five days. Povidone iodine 2% oral rinse was also prescribed to facilitate plaque control. Subjects were adviced to apply ice pack to the area intermittently for 20 minutes over the first 24 to 48 hours to avoid postoperative swelling. Subjects were instructed to maintain oral hygiene, to take soft diet for the first few days and then gradually return to a normal diet. subjects were recalled after 7 days for suture removal .

After 8-10 weeks for mandibular arch, 12-14 weeks for maxillary arch 2nd stage of surgery was done by confirming the osseointegration of the implant. Cover screw was removed and gingival former was placed. Simple interrupted sutures were placed. After one week gingival former was removed and castable plastic abutment was placed and rubber base impression material (FLEXCEED vinyl polysiloxane impression material, manufactured by GC DENTAL PRODUCTS CORP,JAPAN) was used to record the details by closed tray method. Gingival former was placed again, after removing plastic abutment. Impression, castable abutment and implant analog were given to lab, Screw retained platform switched ceramic prosthesis was fabricated and delivered to the subjects by tightening the screw around 25Ncm. The hole was filled with light-cured universal flowable composite resin (G - Aenial manufactured by GC DENTAL CORP,JAPAN). The parameters to be checked are given in the followed table.

OUTCOME VARIABLES:

*SULCUS BLEEDING INDEX (SBI)- 197*1 ***MUHLEMANN AND SON***

An early sign of gingivitis is bleeding on probing and, in 1971, **Muhlemann and Son** described the Sulcus Bleeding Index (SBI).

The Criteria For Scoring Are As Follows:

0 – Healthy Looking papillary and marginal gingiva no bleeding on probing

1 – Healthy Looking Gingiva, Bleeding On Probing

2 – Bleeding On Probing, Change In Color, No Edema

3 – Bleeding On Probing, Change In Color, Slight Edema

4 –Bleeding On Probing, Change In Color, Obvious Edema

5 –Spontaneous Bleeding, Change In Color, Marked Edema

Four gingival units are scored systematically for each tooth: The Labial, Lingual, Marginal Gingival (M Units), Mesial and Distal Papillary Gingival (P Units). Scores for these units are added and divided by four. Adding the scores of the undivided teeth and dividing them by the number of teeth can determine the sulcus bleeding index.

*GINGIVAL INDEX – **APSE ET AL***

Score	
0	Normal mucosa
1	Minimal inflammation with colour change and minor edema
2	Moderate inflammation with redness, edema and glazing
3	Severe inflammation with redness, edema, ulceration and spontaneous bleeding without probing

*PLAQUE INDEX – **MOMBELLI ET AL***

Score	
0	No detection of plaque
1	Plaque only recognized by running a probe across the smooth marginal surface of the implant
2	Plaque can be seen by the naked eye
3	Abundance of soft matter

Mucosal thickness (MT):

For measuring the mucosal thickness endodontic file (Densply) number 15 was used. The file was inserted 1 mm apically under the sulcus and the distance between the tip of file and rubber stop was recorded as the mucosal thickness using an absolute digital caliper.

Width of keratinized tissue (KT):

The keratinized tissue width was measured by using William's probe mid-facially from gingival margin to mucogingival junction of the implant.

Sulcus probing depth (PD):

Depth of sulcus was measured using a plastic probe (Colorvue manufactured by Hu-Friedy Mfg.co, USA) at the mesial (PD1), distal (PD2) and middle of buccal (PD3) and lingual (PD4) areas.

The distance between implant shoulder and alveolar crest:

The level of bone around the implant was calculated by Cone Beam Computed Tomograph CBCT. The distance between implant shoulder and observed alveolar crest will be recorded at the mesial,(MBL), distal(DBL), buccal (BBL) and lingual(LBL) areas of implants.

DENTAL CBCT :

Evaluation of the buccal bone level (BBL), lingual bone level (LBL) ,mesial bone level (MBL) and distal bone level (DBL) were performed with the use of Cone beam CT scanner. CBCT machine which is used to scan is NEWTOM GO, manufactured in Italy.

Maximum field of view by this CBCT machine is 10×10 cm in size. We have analyzed cases with small field of view that is 6×6 cm in size with the resolution of 115 microns. Basic axial slice set up by this machine is 0.15 mm, so that we get the accurate data. According to literature CBCT voxels are isotrophic so that all measurements are accurate.

We have performed CBCT scan before and immediately after implant placement, 3 months after implant placement (immediately after loading) and 1 year after implant placement. The focal planes were adjusted to the center of the buccolingual aspect of the implant and the mesiodistal aspect. NNT software was used to analyze the CBCT data.

Vertical bone resorption was measured from the shoulder of implant to the alveolar ridge using the measuring tool present in the CBCT. From the coronal section, buccal and lingual vertical bone loss was measured and from sagittal section, mesial and distal vertical bone loss was measured. Multiplanar reconstruction was used to analyze Mesio-buccal,disto-buccal , mid-buccal, mesio-lingual, disto-lingual and mid-lingual sites.

Figure 1: Armamentarium for the surgery

Figure 2: NSK SG20 S-Max 20:1 implant contra angle handpiece

Figure 3: NSK Physiodispenser unit

Figure 4: ADIN Implant kit

Figure 5: Drills

Figure 6 : Implant Drive & Hex Drives

Figure 7: Torque ratchet

Figure 8: Paralleling pin

Figure 9: CBCT unit

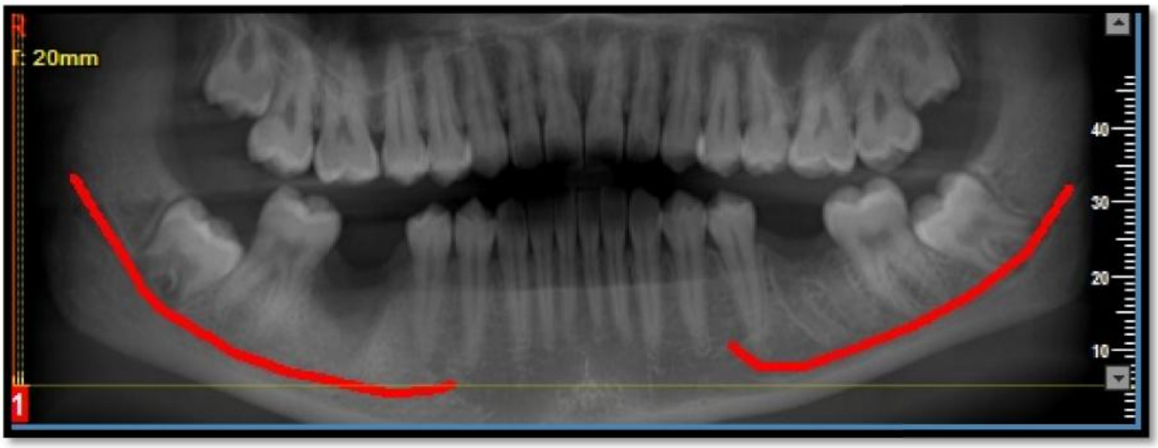


Figure 10: Pre-operative CBCT

Figure 11:Edentulous site at 36,46

Figure 12: Pre operative model

Figure 13: Measurement of width of attached gingiva by

William's probe at implant site

Figure 14: Thickness of keratinized mucosa at implant site

Figure 15: Measurement of mucosal thickness by digital caliper

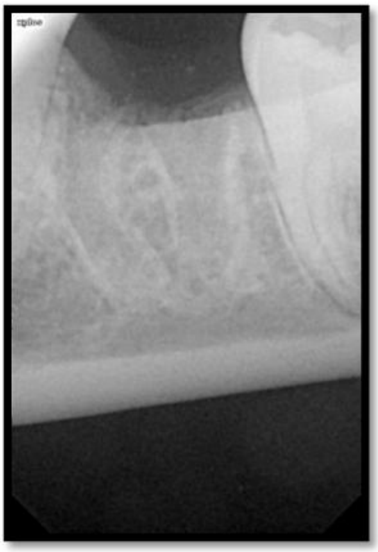


Figure 16: Pre operative RVG for 36

Figure 17: Prefabricated cast with surgical stent

Figure 18: Surgical template placed at implant site

Figure 19: Local anaesthesia given(inferior alveolar nerve block)

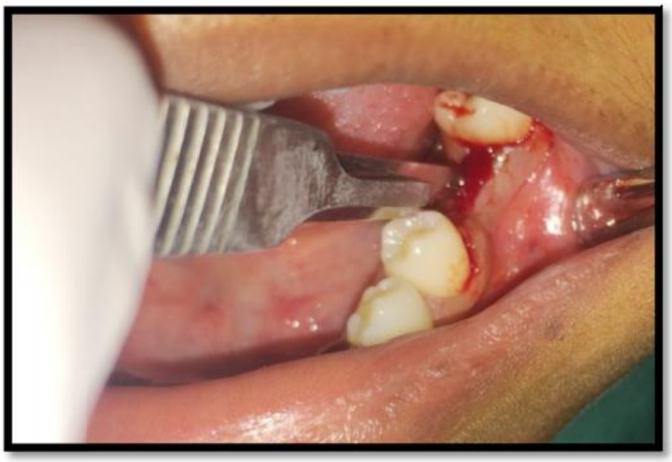


Figure 20: Mid-crestal incision at implant site

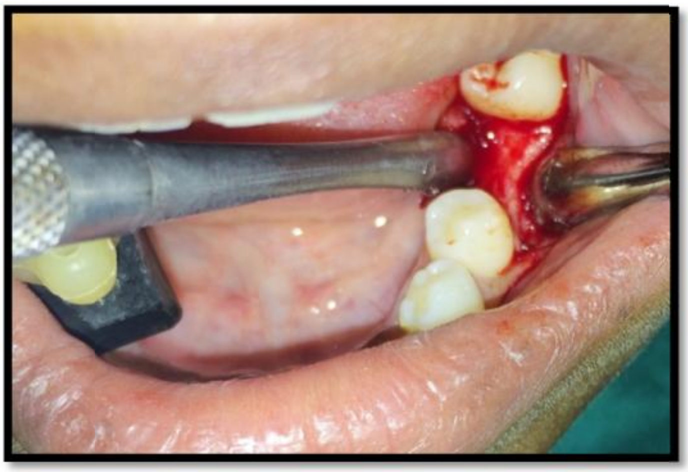


Figure 21: Elevation of full - thickness mucoperiosteal flap

Figure 22: Osteotomy by pilot drill at implant site

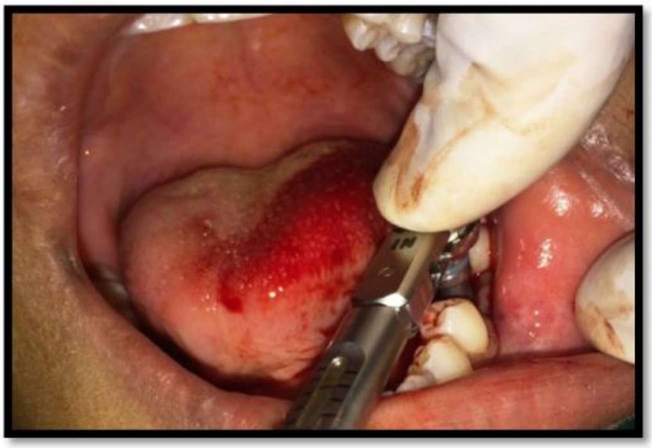


Figure 23: Implant placement

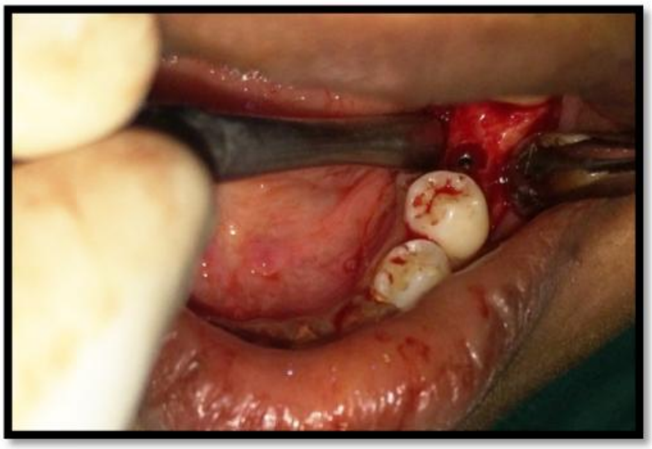


Figure 24: Cover screw placed after insertion of the implant

Figure 25: RVG after implant placement

Figure 26: Suturing after implant placement

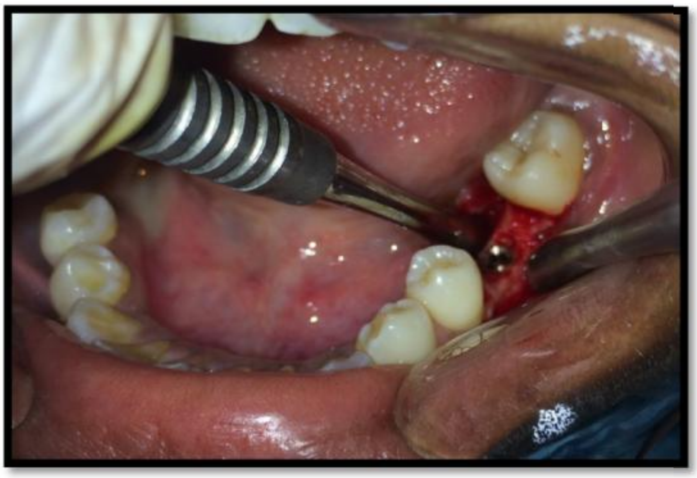


Figure 27: Second stage surgery (cover screw exposed)

Figure 28: Gingival former placed

Figure 29: Cuff formation after 1 week

Figure 30: Castable plastic abutment placed

Figure 31: Elastomeric impression & screw retained platform switched ceramic prosthesis

Figure 32: Checking probing pocket depth immediately after prosthesis placement

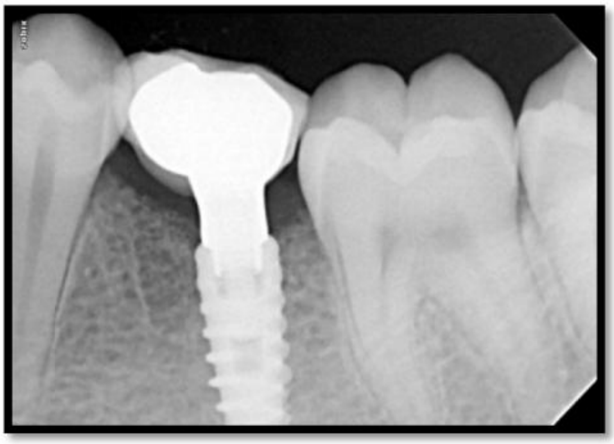


Figure 33: RVG after crown fixation

Figure 34: Post operative model

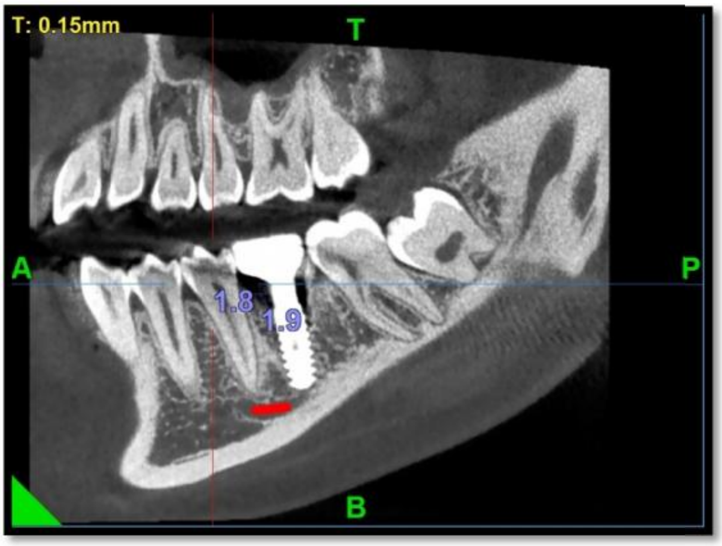


Figure 35: CBCT after 3 months of implant placement.

Measuring mesial horizontal & vertical bone loss in 36.

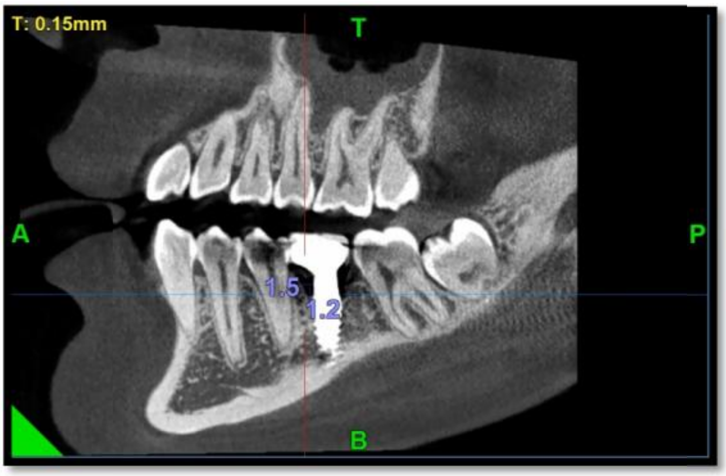


Figure 36: CBCT after 12 months of implant placement.

Measuring mesial horizontal & vertical bone loss in 36.

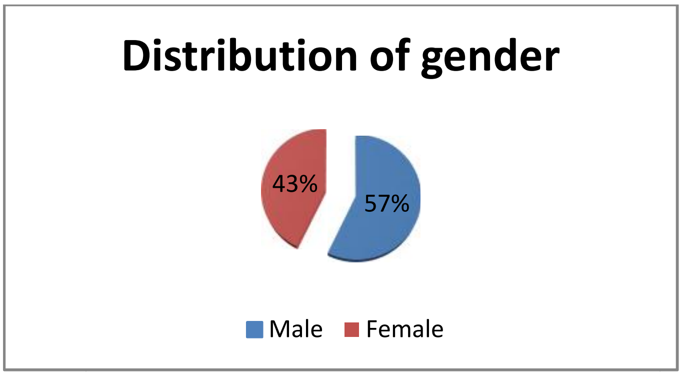
STATISTICAL ANALYSIS

All the clinical and radiological parameters recorded were subjected to the following statistical analysis :

The data obtained during the course of the study was entered in Microsoft Excel and analyzed using SPSS software version 19. Repeated measures **ANOVA** was employed to compare the means of various clinical and radiological parameters. Least significant difference test was performed to know the statistically significant pair. Significance level was set at $p \leq 0.05$.

RESULTS

The present clinico-radiological study was conducted to evaluate peri-implant soft & hard tissue response after single tooth replacement with platform switched implant. Totally 14 participants completed the study. There were eight males (57.1%) and six females (42.9%) in the study. The mean age of the participants was 35.57 ± 13.16 years with minimum of 19 years and maximum of 56 years. Clinical parameters namely the gingival index, plaque index, sulcular bleeding index, probing depth, thickness of keratinized mucosa were recorded. The radiologic parameter, bone loss was measured by using CBCT. All the parameters were recorded before and after implant placement and at 3 months interval till 1 year.



CLINICAL PARAMETERS :

Table 1 describes the descriptive statistics of clinical parameters at baseline. The mean gingival index score was 1.06 ± 0.10 with a minimum score of 0.94 and a maximum score of 1.24. The mean plaque index score was 1.07 ± 0.06 with a minimum score of 0.98 and a maximum score of 1.16. The mean sulcus bleeding index score was 1.06 ± 0.06 with a minimum score of 0.96 and maximum score of 1.16. The mean thickness of keratinized mucosa was 2.98 ± 0.52 mm with a minimum thickness of 2.42 mm and maximum thickness of 3.78 mm. The mean probing pocket depth was 1.25 ± 0.26 mm with a minimum depth of 1.0 mm and maximum depth of 1.5 mm.

Table 2 describes the descriptive statistics of clinical parameters at 3 months. The mean gingival index score was 0.57 ± 0. 03 with a minimum score of 0.52 and maximum score of 0.62. The mean plaque index score was 0.61 ± 0.03 with a minimum score of 0.57 and a maximum score of 0.66. The mean sulcus bleeding index score was 0.60 ± 0.03 with a minimum score of 0.55 and maximum score of 0.66. The mean thickness of keratinized mucosa was 3.21 ± 0.60 mm with a minimum thickness of 2.52 mm and maximum thickness of 4.21 mm. The mean probing pocket depth was 1.75 ± 0.26 mm with a minimum depth of 1.5 mm and maximum depth of 2.0 mm.

Table 3 describes the descriptive statistics of clinical parameters at 6 months. The mean gingival index score was 0.68 ± 0.04 with a minimum score of 0.63 and maximum score of 0.76. The mean plaque index score was 0.71 ± 0.04 with a minimum score of 0.66 and a maximum score of 0.78. The mean sulcus bleeding index score was 0.70 ± 0.04 with a minimum score of 0.64 and maximum score of 0.78. The mean thickness of keratinized mucosa was 3.06 ± 0.59 mm with a minimum thickness of 2.37 mm and maximum thickness of 4.01 mm. The mean probing pocket depth was 2.07 ± 0.33 mm with a minimum depth of 1.5 mm and maximum depth of 2.5 mm.

Table 4 describes the descriptive statistics of clinical parameters at 9 months. The mean gingival index score was 0.77 ± 0.06 with a minimum score of 0.69 and maximum score of 0.87. The mean plaque index score was 0.79 ± 0.05 with a minimum score of 0.71 and a maximum score of 0.87. The mean sulcus bleeding index score was 0.80 ± 0.07 with a minimum score of 0.66 and maximum score of 0.91. The mean thickness of keratinized mucosa was 2.90 ± 0.56 mm with a minimum thickness of 2.22 mm and maximum thickness of 3.72 mm. The mean probing pocket depth was 2.43 ± 0.27 mm with a minimum depth of 2.0 mm and maximum depth of 3.0 mm.

Table 5 describes the descriptive statistics of clinical parameters at 12 months. The mean gingival index score was 0.83 ± 0.04 with a minimum score of 0.76 and maximum score of 0.88. The mean plaque index score was 0.87 ± 0.05 with a minimum score of 0.80 and a maximum score of 0.97. The mean sulcus bleeding index score was 0.87 ± 0.06 with a minimum score of 0.79 and maximum score of 1.03. The mean thickness of keratinized mucosa was 2.85 ± 0.53 mm with a minimum thickness of 2.21 mm and maximum thickness of 3.71 mm. The mean probing pocket depth was 2.75 ± 0.26 mm with a minimum depth of 2.5 mm and maximum depth of 3.0 mm.

Table 6 A & Graph 1 reports the comparison of gingival index across the various time periods (baseline, 3 , 6, 9 , 12 months). On comparing the means, the difference between the means was found to be statistically significant with F value of 30.26 and a p value of 0.00. **Table 6 B** shows the comparison between the various time periods for gingival index. It was found that the difference between each time period (baseline – 3months, baseline – 6 months, baseline – 9 months, baseline 12 months, 3 – 6 months, 3 – 9 months, 3 – 12 months, 6 – 9 months, 6 – 12 months, 9 – 12 months) was statistically significant with a p value of 0.000 for all the time period comparisons.

Table 7 A & Graph 2 reports the comparison of plaque index across the various time periods (baseline, 3 , 6, 9 , 12 months). On comparing the means, the difference between the means was found to be statistically significant with F value of 35.26 and a p value of 0.00. **Table 7 B** shows the comparison between the various time periods for plaque index. It was found that the difference between each time period (baseline – 3months, baseline – 6 months, baseline – 9 months, baseline 12 months, 3 – 6 months, 3 – 9 months, 3 – 12 months, 6 – 9 months, 6 – 12 months, 9 – 12 months) was statistically significant with a p value of 0.000 for all the time period comparisons.

Table 8 A & Graph 3 reports the comparison of sulcus bleeding index across the various time periods (baseline, 3 , 6, 9 , 12 months). On comparing the means, the difference between the means was found to be statistically significant with F value of 9.61 and a p value of 0.008.

Table 8 B shows the comparison between the various time periods for sulcus bleeding index. It was found that the difference between each time period (baseline – 3months, baseline – 6 months, baseline – 9 months, baseline 12 months, 3 – 6 months, 3 – 9 months, 3 – 12 months, 6 – 9 months, 6 – 12 months, 9 – 12 months) was statistically significant with a p value of 0.000 for all the time period comparisons.

Table 9 A & Graph 4 reports the comparison of thickness of keratinized mucosa across the various time periods (baseline, 3 , 6, 9 , 12 months). On comparing the means, the difference between the means was found to be statistically significant with F value of 70.97 and a p value of 0.00. **Table 9 B** shows the comparison between the various time periods for thickness of keratinized mucosa. It was found that the difference between each time period (baseline – 3months, baseline – 6 months, baseline – 9 months, baseline 12 months, 3 – 6 months, 3 – 9 months, 3 – 12 months, 6 – 9 months, 6 – 12 months, 9 – 12 months) was statistically significant with a p value of 0.000 for all except baseline -6 months (p value 0.098 – statistically insignificant), baseline – 9 months (p value 0.020) and baseline – 12 months (p value 0.001)

Table 10 A & Graph 5 reports the comparison of probing pocket depth across the various time periods (baseline, 3 , 6, 9 , 12 months). On comparing the means, the difference between the means was found to be statistically significant with F value of 424.36 and a p value of 0.00. **Table 10 B** shows the comparison between the various time periods for probing pocket depth. It was found that the difference between each time period (baseline – 3months, baseline – 6 months, baseline – 9 months, baseline 12 months, 3 – 6 months, 3 – 9 months, 3 – 12 months, 6 – 9 months, 6 – 12 months, 9 – 12 months) was statistically significant with a p value of 0.000

for all time period comparisons except 3 – 6 months (p value = 0.002) and 6 – months (p value = 0.001).

RADIOLOGICAL PARAMETER:

Table 11 describes the radiological parameters at baseline. The mean bone loss at the mesial horizontal site was 0.24 ± 0.20 mm with a minimum of 0.0 mm and a maximum of 0.5 mm. The mean bone loss at the mesial vertical site was 0.26± 0.13 mm with a minimum of 0.0 mm and a maximum of 0.5 mm. The mean bone loss at the distal horizontal site was 0.23 ± 0.15 mm with a minimum of 0.0 mm and a maximum of 0.4 mm. The mean bone loss at the distal vertical site was 0.17 ± 0.12 mm with a minimum of 0.0 mm and a maximum of 0.4 mm. The mean bone loss at the buccal site was 0.06 ± 0.12 mm with a minimum of 0.0 mm and a maximum of 0.4 mm. The mean bone loss at the lingual site was 0.03 ± 0.06 mm with a minimum of 0.0 mm and a maximum of 0.2 mm. The mean bone loss was 0.17 ± 0.07 mm with a minimum of 0.05 mm and a maximum of 0.27 mm.

Table 12 describes the radiological parameters at 3 months. The mean bone loss at the mesial horizontal site was 1.69 ± 0.61 mm with a minimum of 0.80 mm and a maximum of 2.7 mm. The mean bone loss at the mesial vertical site was 1.44± 0.59 mm with a minimum of 0.60 mm and a maximum of 2.4 mm. The mean bone loss at the distal horizontal site was 1.39 ± 0.44 mm with a minimum of 0.70 mm and a maximum of 2.1 mm. The mean bone loss at the distal vertical site was 1.2 ± 0.43 mm with a minimum of 0.40 mm and a maximum of 1.9 mm. The mean bone loss at the buccal site was 0.32 ± 0.37 mm with a minimum of 0.0 mm and a maximum of 0.9 mm. The mean bone loss at the lingual site was 0.18 ± 0.23 mm with a minimum of 0.0 mm and a maximum of 0.7 mm. The mean bone loss was 1.04 ± 0.30 mm with a minimum of 0.57 mm and a maximum of 1.52 mm.

Table 13 describes the radiological parameters at 12 months. The mean bone loss at the mesial horizontal site was 1.13 ± 0.47 mm with a minimum of 0.60 mm and a maximum of 1.9 mm. The mean bone loss at the mesial vertical site was 1.05± 0.39 mm with a minimum of 0.40 mm and a maximum of 1.8 mm. The mean bone loss at the distal horizontal site was 1.1 ± 0.33 mm with a minimum of 0.60 mm and a maximum of 1.6 mm. The mean bone loss at the distal vertical site was 0.85 ± 0.28 mm with a minimum of 0.30 mm and a maximum of 1.4 mm. The mean bone loss at the buccal site was 0.29 ± 0.31 mm with a minimum of 0.0 mm and a maximum of 0.8 mm. The mean bone loss at the lingual site was 0.16 ± 0.17 mm with a minimum of 0.0 mm and a maximum of 0.4 mm. The mean bone loss was 0.76 ± 0.19 mm with a minimum of 0.5 mm and a maximum of 1.12 mm.

Table 14 A & Graph 6 reports the comparison of bone loss across the time periods (baseline, 3 months and 12 months). On comparing the means, the difference between the means was found to be statistically significant with F value of 254.72 and p value of 0.000. **Table 14 B** shows the comparison between the time periods (baseline – 3months, baseline – 12 months, 3 – 12 months) and it was found to be statistically significant for all the time period comparisons with p value of 0.000

CLINICAL PARAMETERS

Table 1.Descriptive statistics of clinical parameters at baseline

Parameter	Minimum	Maximum	Mean	Std. Deviation
Gingival Index	0.94	1.24	1.06	0.10
Plaque Index	0.98	1.16	1.07	0.06
Sulcus bleeding Index	0.96	1.16	1.06	0.06
Thickness of keratinized mucosa	2.42	3.78	2.98	0.52
Probing pocket depth	1.00	1.50	1.25	0.26

Table 2.Descriptive statistics of clinical parameters at 3 months

Parameter	Minimum	Maximum	Mean	Std. Deviation
Gingival Index	.52	.62	.57	.03
Plaque Index	.57	.66	.61	.03
Sulcus bleeding Index	.55	.66	.60	.03
Thickness of keratinized mucosa	2.52	4.21	3.21	.60
Probing pocket depth	1.50	2.00	1.75	.26

Table 3.Descriptive statistics of clinical parameters at 6 months

Parameter	Minimum	Maximum	Mean	Std. Deviation
Gingival Index	.63	.76	.68	.04
Plaque Index	.66	.78	.71	.04
Sulcus bleeding Index	.64	.78	.70	.04
Thickness of keratinized mucosa	2.37	4.01	3.06	.59
Probing pocket depth	1.50	2.50	2.07	.33

Table 4. Descriptive statistics of clinical parameters at 9 months

Parameter	Minimum	Maximum	Mean	Std. Deviation
Gingival Index	.69	.87	.77	.06
Plaque Index	.71	.87	.79	.05
Sulcus bleeding Index	.66	.91	.80	.07
Thickness of keratinized mucosa	2.22	3.72	2.90	.56
Probing pocket depth	2.00	3.00	2.43	.27

Table 5. Descriptive statistics of clinical parameters at 12 months

Parameter	Minimum	Maximum	Mean	Std. Deviation
Gingival Index	.76	.88	.83	.04
Plaque Index	.80	.97	.87	.05
Sulcus bleeding Index	.79	1.03	.87	.06
Thickness of keratinized mucosa	2.21	3.71	2.85	.53
Probing pocket depth	2.50	3.00	2.75	.26

Table 6 A: Comparison of Gingival index across the timeline

Time	Mean	SD	F value	p value
Baseline	1.06	0.10	30.26	.000
3 months	0.57	0.03		
6 months	0.68	0.04		
9 months	0.77	0.06		
12 months	0.83	0.04		

F and p value obtained from Repeated measures ANOVA. p value ≤ 0.05 is significant

Table 6 B: Pairwise comparison across the time line

Group	Group	Mean difference	p value
1	2	.484*	.000
	3	.376*	.000
	4	.285*	.000
	5	.226*	.000
2	3	-.109*	.000
	4	-.199*	.000
	5	-.258*	.000
3	4	-.091*	.000
	5	-.150*	.000
4	5	-.059*	.000

p value obtained from Least Significant Difference test. p value ≤ 0.05 is significant

Graph 1:Comparison of Gingival index across the timeline

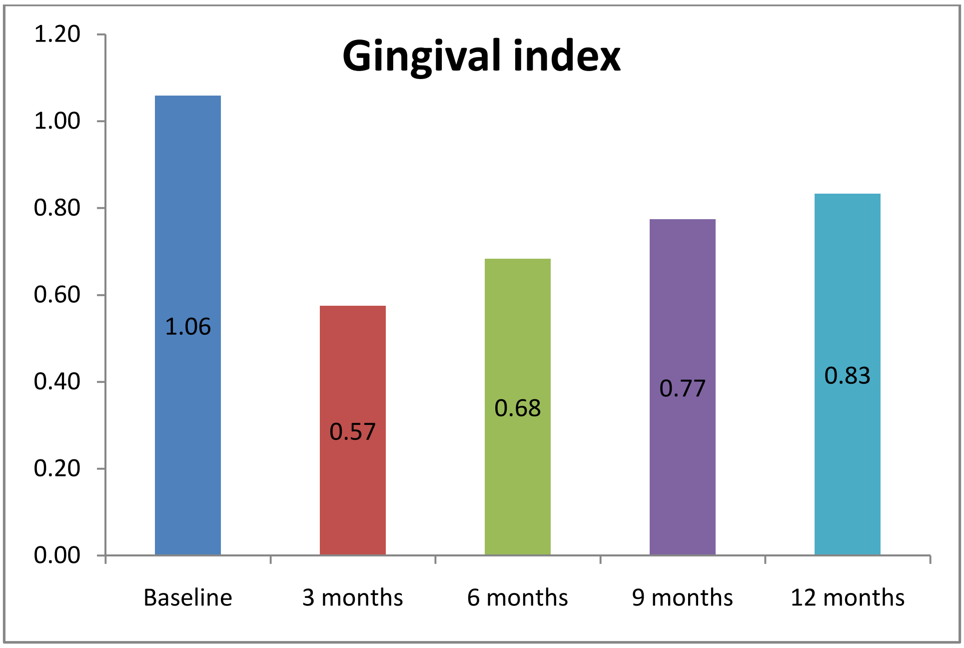


Table 7 A: Comparison of Plaque index across the timeline

Time	Mean	SD	F value	p value
Baseline	1.07	0.06	35.26	.000
3 months	0.61	0.03		
6 months	0.71	0.04		
9 months	0.79	0.05		
12 months	0.87	0.05		

F and p value obtained from Repeated measures ANOVA. p value ≤ 0.05 is significant

Table 7 B: Pairwise comparison across the time line

Group	Group	Mean difference	p value
1	2	.456*	.000
	3	.357*	.000
	4	.275*	.000
	5	.196*	.000
2	3	-.098*	.000
	4	-.180*	.000
	5	-.260*	.000
3	4	-.082*	.000
	5	-.162*	.000
4	5	-.080*	.000

p value obtained from Least Significant Difference test. p value ≤ 0.05 is significant

Graph 2: Comparison of Plaque index across the timeline

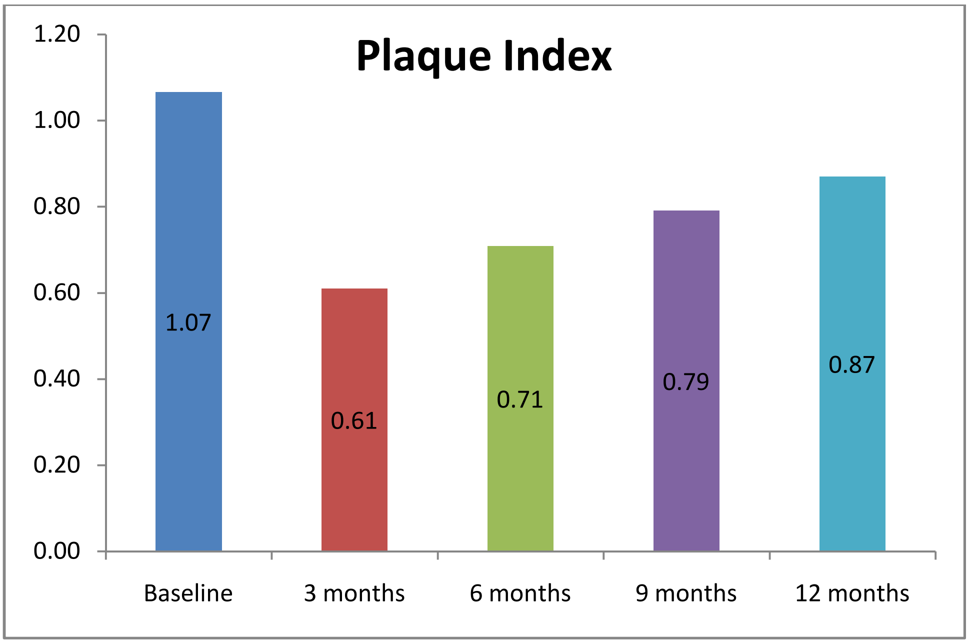


Table 8 A: Comparison of Sulcus bleeding index across the timeline

Time	Mean	SD	F value	p value
Baseline	1.06	0.06	9.61	.008
3 months	0.60	0.03		
6 months	0.70	0.04		
9 months	0.80	0.07		
12 months	0.87	0.06		

F and p value obtained from Repeated measures ANOVA. p value ≤ 0.05 is significant

Table 8 B: Pairwise comparison across the time line

Group	Group	Mean difference	p value
1	2	.461*	.000
	3	.360*	.000
	4	.264*	.000
	5	.189*	.000
2	3	-.101*	.000
	4	-.197*	.000
	5	-.272*	.000
3	4	-.096*	.000
	5	-.171*	.000
4	5	-.075*	.000

p value obtained from Least Significant Difference test. p value ≤ 0.05 is significant

Graph 3: Comparison of Sulcus bleeding index across the timeline

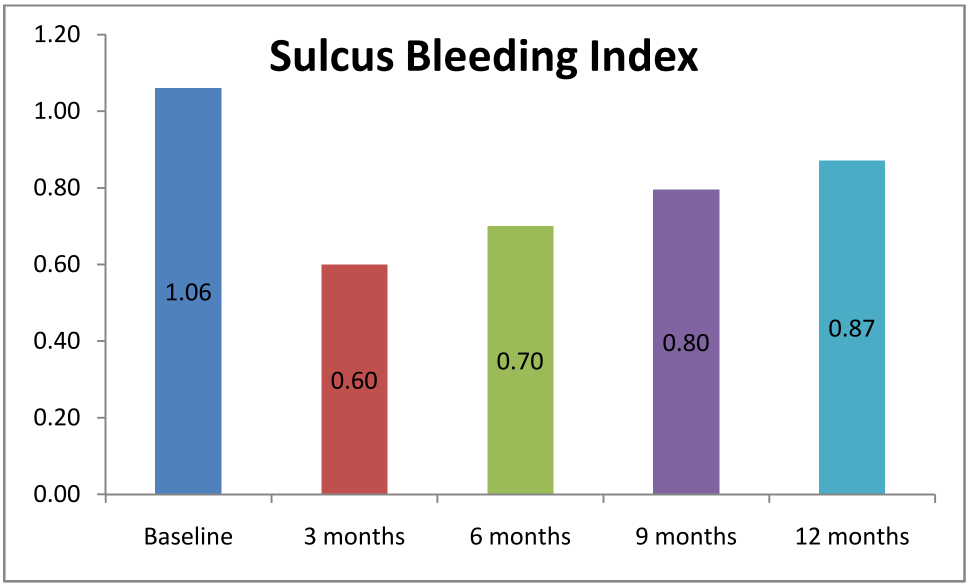


Table 9 A: Comparison of thickness of keratinized mucosa across the timeline (mm)

Time	Mean	SD	F value	p value
Baseline	2.98	0.52	70.97	.000
3 months	3.21	0.60		
6 months	3.06	0.59		
9 months	2.90	0.56		
12 months	2.85	0.53		

F and p value obtained from Repeated measures ANOVA. p value ≤ 0.05 is significant

Table 9 B: Pairwise comparison across the time line

Group	Group	Mean difference	p value
1	2	-.229*	.000
	3	-.076	.098
	4	.087*	.020
	5	.136*	.001
2	3	.153*	.000
	4	.316*	.000
	5	.365*	.000
3	4	.163*	.000
	5	.212*	.000
4	5	.049*	.006

p value obtained from Least Significant Difference test. p value ≤ 0.05 is significant

Graph 4: Comparison of thickness of keratinized mucosa across the timeline

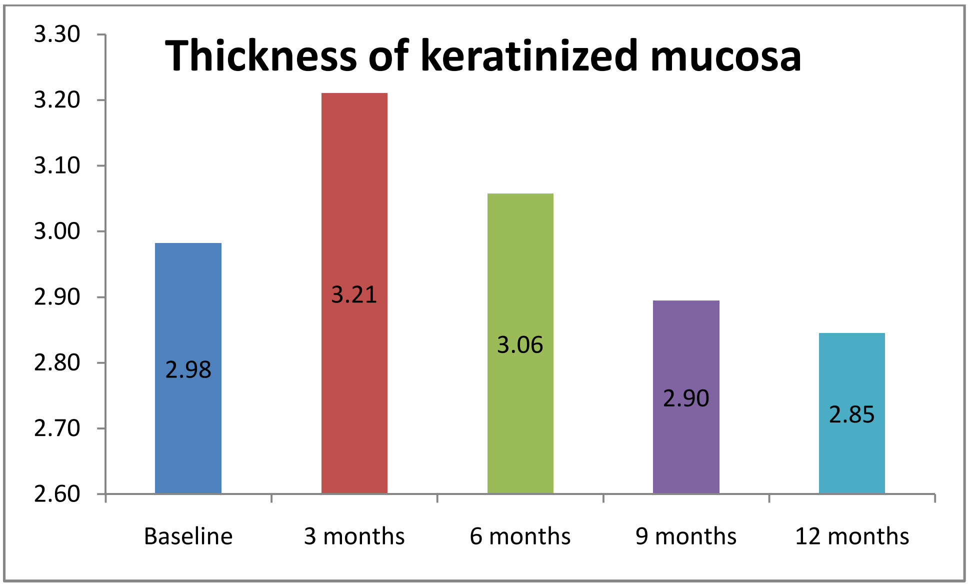


Table 10 A: Comparison of Probing pocket depth across the timeline (mm)

Time	Mean	SD	F value	p value
Baseline	1.25	0.26	424.36	.000
3 months	1.75	0.26		
6 months	2.07	0.33		
9 months	2.43	0.27		
12 months	2.75	0.26		

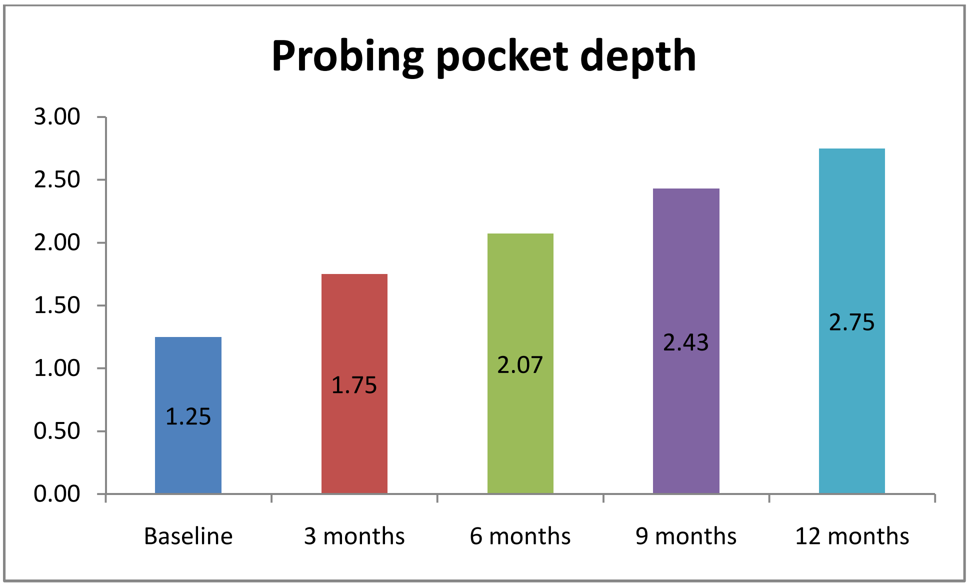
F and p value obtained from Repeated measures ANOVA. p value ≤ 0.05 is significant

Table 10 B: Pairwise comparison across the time line

Group	Group	Mean difference	p value
1	2	-.500*	.000
	3	-.821*	.000
	4	-1.179*	.000
	5	-1.500*	.000
2	3	-.321*	.002
	4	-.679*	.000
	5	-1.000*	.000
3	4	-.357*	.001
	5	-.679*	.000
4	5	-.321*	.000

p value obtained from Least Significant Difference test. p value ≤ 0.05 is significant

Graph 5: Comparison of Probing pocket depth across the timeline



RADIOLOGICAL PARAMETER

Table 11.Descriptive statistics of radiological parameters at baseline (mm)

Sites	Minimum	Maximum	Mean	Std. Deviation
Mesia Horizontal	.00	.50	.24	.20
Mesia Vertical	.00	.50	.26	.13
Distal Horizontal	.00	.40	.23	.15
Distal Vertical	.00	.40	.17	.12
Buccal	.00	.40	.06	.12
Lingual	.00	.20	.03	.06
Overall	.05	.27	.17	.07

Table 12.Descriptive statistics of radiological parameters at 3 months (mm)

Sites	Minimum	Maximum	Mean	Std. Deviation
Mesia Horizontal	.80	2.70	1.69	.61
Mesia Vertical	.60	2.40	1.44	.59
Distal Horizontal	.70	2.10	1.39	.44
Distal Vertical	.40	1.90	1.20	.43
Buccal	.00	.90	.32	.37
Lingual	.00	.70	.18	.23
Overall	.57	1.52	1.04	.30

Table 13.Descriptive statistics of radiological parameters at 12 months (mm)

Sites	Minimum	Maximum	Mean	Std. Deviation
Mesia Horizontal	.60	1.90	1.13	.47
Mesia Vertical	.40	1.80	1.05	.39
Distal Horizontal	.60	1.60	1.10	.33
Distal Vertical	.30	1.40	.85	.28
Buccal	.00	.80	.29	.31
Lingual	.00	.40	.16	.17
Overall	.50	1.12	.76	.19

Table 14 A: Comparison of bone loss across the timeline (mm)

Time	Mean	SD	F value	p value
Baseline	.17	.07	254.72	.000
3 months	1.04	.30		
12 months	.76	.19		

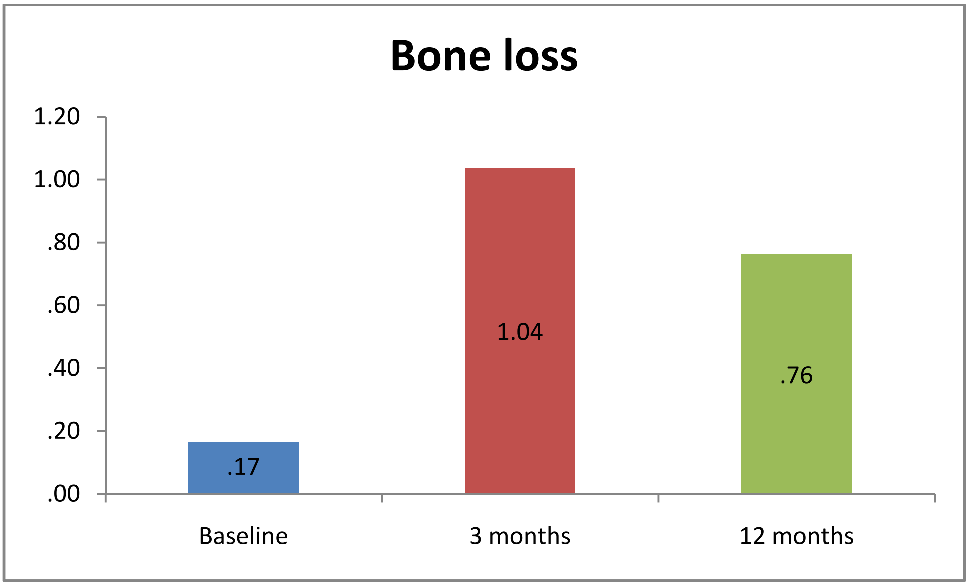
F and p value obtained from Repeated measures ANOVA. p value ≤ 0.05 is significant

Table 14 B: Pairwise comparison across the time line

Group	Group	Mean difference	p value
1	2	-.871*	.000
	3	-.595*	.000
2	3	.276*	.000

p value obtained from Least Significant Difference test. p value ≤ 0.05 is

Graph 6 : Comparison of bone loss across the timeline



DISCUSSION

For many decades, Implants have been used to support dental prosthesis, but they have not always provided a favorable results. This situation has changed after the entry of endosseous osseointegrated dental implants [14]. Since then many types of implants have evolved and various modifications in its design have been made to achieve better osseointegration for its long term stability[62]. The preservation of the crestal bone and soft tissue around implants is an important factor for implant success both functionally and esthetically[63,64,65,66].

Radiographs have important role for determination of bone quality, quantity, implant position, orientation and osseointegration. The conventional radiographs are more prone to distortion in a short period, which limits the value in determining the actual quantity and quality of bone. Therefore CBCT of the edentulous area was taken pre operatively for analysis of the quantity and quality of bone three dimensionally and also to evaluate the bone changes on subsequent follow up visit.

The current study was conducted with the aim to determine the changes in crestal bone level by using CBCT and also to evaluate the soft tissue changes around the platform switched implants during 3 months, 6 months, 9 months and 12 months after implant placement. The study was conducted on 14 patients presented with missing maxillary / mandibular posterior tooth. The patients included in the study were periodontally and systemically healthy.

The clinical parameters recorded in the present study to evaluate soft tissue changes are gingival index, plaque index, sulcular bleeding index, probing depth and thickness of keratinized mucosa. Oral hygiene status was assessed by plaque index, gingival index and sulcular bleeding index. The oral hygiene status was satisfactory and the values were at low levels during the entire study, since the patients also maintained good oral hygiene.

It was reported by **De Angelo et al** in **2007** that probing depth was used as the defining clinical parameters for the determination of soft tissue maturity[67]. Probing depth was less than 3mm during the entire study at various intervals. The mean probing depth showed statistically significant difference across various time periods.

Keratinized mucosal health is an important factor for success of the implant. **Tonnetti et al** in **1995** suggested that clinically healthy keratinized mucosa and the local response in peri-implant mucosa is essential for implant success[68,69]. **Rezaei Esfahrood et al** in **2016** reviewed various articles and proposed that keratinized mucosa over the crestal bone is the main factor establishing biologic width and prevents crestal bone resorption[63]. **Linkevicius et al** in **2010** conducted a study and stated that platform switched implants may not preclude early crestal bone loss if mucosal tissue thickness is 2mm or less before implant placement. Initial thin mucosal tissue is not sufficient for stable peri-implant seal formation[49]. This lead to crestal bone loss during biologic width formation[70]. Initial keratinized mucosal thickness more than 2mm was selected for the present study. The mucosal thickness increased after 3 months during second stage surgery for biological width formation. The mean keratinized mucosal thickness showed statistically significant difference across various time periods.

Previous studies on platform switched implants have shown similar success and survival rates as platform matched implants. Review of various literatures suggested that crestal bone loss was minimized using platform switched implants.

Ericsson et al in **1995** detected inflammatory cell infiltrate associated with IAJ of two-piece implants. The authors suggested that the formation of infiltrate in the microgap contaminated with oral bacteria acts as a defensive mechanism[71]. Platform switched implants repositions infiltrate in a 90 degree confined area of exposure instead of 180 degree surface of regular connection implants[49]. Thus smaller infiltrate around platform switched implants results in less bone loss. **Lazzarre et al** in **2006** described preservation of crestal bone using platform switched implants with the radiographic observations made over a 13 year period. The inward horizontal repositioning of the IAJ shifted the microgap away from the bone and crestal bone loss is reduced[17].

Albrektsson et al in **1986** proposed a mean crestal bone loss less than 1.6mm during first post surgical year was accepted as a criterion for implant success. They also proposed annual crestal bone loss ranging from 0.05mm to 0.13mm in the maintenance period[30,72]. In a study by **Salamanca et al** in **2017** it was concluded that platform switching seemed to be more effective for a better peri-implant alveolar bone vertical and horizontal gap reduction at 1 year[60].

The present study showed a mean bone loss of 0.17 ± 0.07mm at baseline which progressed and reached a mean bone loss of 1.04 ± 0.30mm at 3 months. The bone loss at 3 months has occurred after second stage surgery with the biological width formation. The mean bone loss at 1 year follow up was 0.76 ± 0.19mm. The mean difference of bone loss was 0.595 on comparison of base line and 1 year with the p value of 0.000 which was found to be statistically significant there by validating our hypothesis. The difference between the means across the time period was found to be statistically significant with the F value of 254.72 and p value of 0.000. Thus the bone loss was minimal using platform switched implants. The platform switched implants was effective in preserving crestal bone and relevant with the above studies.

The 5 year study conducted by **Vigolo et al** in **2009** provided mixed results that bone loss was minimal using platform switched implants when compared with matched implants at 1 yr after implant placement. They observed that there was no significant difference in marginal bone loss on subsequent follow ups[20].

With the limitations of the study, it was concluded that the platform switched implants prevent early crestal bone loss.

SUMMARY AND CONCLUSION

The present study was conducted to evaluate the peri-implant soft & hard tissue response after single tooth replacement with platform switched implant. 14 subjects in age range of 18-60 years,with atleast one missing maxillary/ mandibular posterior tooth were selected and received 14 platform switched implants. Clinical parameters namely the gingival index, plaque index, sulcular bleeding index, probing depth and thickness of keratined mucosa were recorded. The radiological parameter, bone loss was measured at 6 sites namely mesial horizontal, mesial vertical, distal horizontal, distal vertical, buccal and lingual by using CBCT. All the parameters were recorded before and after implant placement and at 3 months interval till one year.

From the results of the present study, it was found that soft tissue parameters showed statistically significant differences ($p<0.05$) at baseline,3 months ,6 months, 9 months and 12months after implant placement. The marginal bone loss measured at baseline, 3 months, 12 months after implant placement showed minimal bone loss which was statistically significant.

With the limitations of the present study it was concluded that the platform switched implants prevent early crestal bone loss and can be used as an effective treatment modality for replacement of missing tooth.

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ANNEXURE

ANNEXURE-1

INSTITUTIONAL ETHICAL COMMITTEE

Best Dental Science College and Hospital
Ultra Nagar, Madurai - 625 104.
RECOGNIZED BY DENTAL COUNCIL OF INDIA, NEW DELHI
AFFLIATED TO THE TAMILNADU Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI)

CHAIRPERSON

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PRINCIPAL
Dr. Vijayalakshmi. K, MDS

MEMBER SECRETARY
Dr. Sudarshan.R, MDS

IRB/IEC Reference No: 2016-STU-BrII-BEN-22

Project title: Evaluation of peri-implant soft and hard tissue response after single tooth replacement with platform switched implant- A clinico radiographic study

Principal Investigator: Dr. V.Benedict, PG student

Review: New/Revised/Expedited

Date of Review: 27/09/2016

Date of previous review, if revised application:

Decision of the IEC/IRB:

- Provisional approval to conduct the study is being given
- The results of this study, along with summary are to be submitted for obtaining final approval

Recommended time period: one year (28-09-17)

PRINCIPAL
BEST DENTAL SCIENCE COLLEGE
MADURAI-625104

ETHICS COMMITTEE SIGN DATE BDSC

INSTITUTIONAL REVIEW BOARD SIGN DATE BDSC

Signature of Member Secretary

NB:

- Inform IRB/IEC immediately in case of any issue(s)/adverse events
- Inform IRB/IEC in case of any change of study procedure, site and investigator
- This permission is only for the period mentioned above
- Annual report to be submitted to IEC/IRB
- Members of IEC/IRB have right to monitor the trail with prior intimation

ANNEXURE – 2

ANNEXURE

DEPARTMENT OF PERIODONTOLOGY

BEST DENTAL SCIENCE COLLEGE & HOSPITAL, MADURAI

DR.MGR MEDICAL UNIVERSITY

INFORMED CONSENT FORM

Name : Mr/Ms/Mrs	**OP.No :**
Address :	**SEX : Male/Female**
	AGE : Years

I, _________________________________, exercising my free power of choice, hereby give my consent to be included as a participant in the study.

I agree to the following :

1. I have been informed to my satisfaction about the purpose of the study and procedures.

2. I understand that the study involves questions which may sometimes be personal.

3. I agree to co-operate fully for complete examination.

4. I agree to give my blood sample for investigation.

5. I agree to report to my doctor for a regular follow up and when required for the research.

6. I have informed my doctor about all the medications that I am currently taking.

7. I hereby give permission to use my medical records for research purpose. I have been told that the investigating doctor and the institution will keep my identity confidential.

8. I understand that I have rights to withdraw myself from the study and also that the investigator has the right to exclude me from the research at any point of time.

SIGNATURE OF THE PARTICIPANT

ANNEXURE - 2

ஒப்புதல் படிவம்

திரு / திருமதி / செல்வி ....
வயது .... த/பெ, க/பெ, ...
.... என்ற முகவரியில் வசித்து வரும் நான் முழு சுயநினைவுடன் மனப்பூர்வமாகவும் யாருடைய தூண்டுதலின் பேரிலும் அல்லாமலும் உறுதி

கூறுவது என்னவென்றால்,

1. செயல்முறையினை பற்றி எனக்கு நன்கு விளக்கப்பட்டுள்ளது. மேலும் இதில் வரும் நன்மை தீமையினை என் சுயநினைவோடு புரிந்து கொண்டேன். இதன் மூலம் என்னுடைய மனப்பூர்வமான சம்மதத்தை உறுதிப்படுத்துகிறேன்.

2. நான் நீங்கள் அழைக்கும் போது மறுபடியும் வந்து வாய் பரிசோதனைக்கு உங்களுக்கு முழு ஒத்துழைப்பு தருகிறேன்.

இடம் : அல்ட்ரா பல் மருத்துவமனை,
ஈறு நோய் பிரிவு,
மதுரை.

கையொப்பம்

நாள் :

ANNEXURE - 3

DEPARTMENT OF PERIODONTOLOGY AND IMPLANTOLOGY

BEST DENTAL SCIENCE COLLEGE AND HOSPITAL

DR.MGR MEDICAL UNIVERSITY

EVALUATION OF PERI - IMPLANT SOFT AND HARD TISSUE RESPONSE AFTER SINGLE TOOTH REPLACEMENT WITH PLATFORM SWITCHED IMPLANT - A CLINICO RADIOGRAPHIC STUDY

IMPLANT CASE SHEET

Demographical Information:-

Patient's O P No :	
Patient's Name :	Phone No :
Age :	Occupation :
Gender :	Marital status :
Education :	Economy :
Habits :	Address :
Date of Operation :	Date of Delivery of Crown :

History:

Medical History :

Dental History :

Clinical Examination:

Oral Hygiene:

Periodontal Condition:

State of Occlusion:

Missing Teeth:

8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Number of Missing Teeth:

Width of Ridge:

I Buccolingual-

II Mesiodistal-

Inter-Maxillary Space:

Artificial Appliances:

Investigation:

Radiographical Findings: O.P.G ………………… PERIAPICAL ………………..

1. Distance From The Crest Of The Ridge :
   i. Maxillary Sinus
   ii. Nasal Floor
   iii. Inferior Alveolar Canal
2. Adjacent Teeth:
3. Condition Of Bone:

Blood Investigations (on need)

Diagnosis:

Prognosis:

Management:

Preoperative Assessment:

Type of Implant:

Site of Implant:

Number of Implant:

Length of Implant:

Width of Implant:

Operative notes:

Postoperative notes:

Follow up:

Gingival former:

Prosthetic work:

GINGIVAL INDEX (APSE et al)-1991

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

Score = **MILD GINGIVITIS/MODERATE GINGIVITIS/SEVERE GINGIVITIS**

PLAQUE INDEX(MOMBELLI et al)-1987

B																
P																

B																
L																

Score = **MILD GINGIVITIS/MODERATE GINGIVITIS/SEVERE GINGIVITIS**

SULCUS BLEEDING INDEX (MUHLEMANN AND SON 1971)

B																
P																

B																
L																

Score = **MILD GINGIVITIS/MODERATE GINGIVITIS/SEVERE GINGIVITIS**

PROBING DEPTH

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

score

PARAMETERS	BASELINE	3MONTH	6MONTHS	9MONTHS	1 YEAR
PLAQUE INDEX					
GINGIVAL INDEX					
MODIFIED SULCUS BLEEDING INDEX					
PROBING POCKET DEPTH					
THICKNESS OF KERATINIZED MUCOSA					

RADIOGRAPHIC INTERPRETATION

CRESTAL BONE LOSS	IN CBCT
AT BASE LINE	
AT 1 YEAR	

	PROPOSED DATE	REPORTED DATE
AT BASELINE		
AFTER 3 MONTHS		
AFTER 6 MONTHS		
AFTER 9 MONTHS		
AT 1 YEAR		

DATE	TREATMENT DONE	STAFF INCHARGE

ANNEXURE – 4

MASTER CHART

S.NO	AGE	SEX	Gingival Index				
			Baseline	3 Months	6 Months	9 Months	12 Months
1	35	M	1.112	0.548	0.758	0.83	0.862
2	35	M	1.112	0.548	0.758	0.83	0.862
3	22	M	0.943	0.546	0.742	0.804	0.867
4	42	F	0.941	0.585	0.656	0.726	0.804
5	52	M	1.241	0.617	0.679	0.867	0.882
6	52	M	1.241	0.617	0.679	0.867	0.882
7	42	F	0.941	0.585	0.656	0.726	0.804
8	27	M	1.032	0.585	0.664	0.687	0.757
9	20	F	1.032	0.515	0.703	0.742	0.882
10	56	M	1.04	0.57	0.632	0.75	0.828
11	19	F	1.019	0.607	0.66	0.741	0.785
12	19	F	1.019	0.607	0.66	0.741	0.785
13	30	M	1.133	0.58	0.677	0.766	0.822
14	47	F	1.018	0.535	0.642	0.758	0.839

S.NO	AGE	SEX	Plaque Index				
			Baseline	3 Months	6 Months	9 Months	12 Months
1	35	M	1.086	0.588	0.725	0.822	0.919
2	35	M	1.086	0.588	0.725	0.822	0.919
3	22	M	1.088	0.656	0.781	0.867	0.882
4	42	F	0.975	0.64	0.664	0.75	0.835
5	52	M	1.158	0.578	0.75	0.859	0.875
6	52	M	1.158	0.578	0.75	0.859	0.875
7	42	F	0.975	0.64	0.656	0.75	0.835
8	27	M	1.104	0.664	0.695	0.71	0.796
9	20	F	1.056	0.632	0.734	0.82	0.968
10	56	M	1.032	0.609	0.687	0.757	0.843
11	19	F	1.009	0.571	0.678	0.767	0.821
12	19	F	1.009	0.571	0.678	0.767	0.821
13	30	M	1.158	0.637	0.717	0.774	0.935
14	47	F	1.027	0.589	0.678	0.741	0.857

S.NO	AGE	SEX	Sulcus Bleeding Index				
			Baseline	3 Moths	6 Months	9 Months	12 Months
1	35	M	1.025	0.556	0.693	0.862	0.911
2	35	M	1.025	0.556	0.693	0.862	0.911
3	22	M	1.096	0.64	0.75	0.859	0.906
4	42	F	0.958	0.625	0.679	0.742	0.851
5	52	M	1.083	0.585	0.781	0.851	0.89
6	52	M	1.083	0.585	0.781	0.851	0.89
7	42	F	0.958	0.625	0.679	0.742	0.851
8	27	M	1.161	0.625	0.64	0.656	0.789
9	20	F	1.137	0.57	0.671	0.914	1.031
10	56	M	1.04	0.656	0.695	0.773	0.867
11	19	F	1.038	0.598	0.687	0.732	0.812
12	19	F	1.038	0.598	0.687	0.732	0.812
13	30	M	1.125	0.612	0.693	0.814	0.846
14	47	F	1.074	0.553	0.669	0.75	0.83

S.NO	AGE	SEX	Thickness Of Keratinized Mucosa				
			Baseline	3 Months	6 Months	9 Months	12 Months
1	35	M	3.53	3.73	3.62	3.49	3.45
2	35	M	3.63	3.78	3.52	3.47	3.42
3	22	M	2.85	2.97	2.75	2.69	2.69
4	42	F	2.54	2.62	2.55	2.41	2.41
5	52	M	3.42	3.82	3.71	3.52	3.41
6	52	M	3.52	4.01	3.88	3.62	3.44
7	42	F	2.44	2.52	2.37	2.29	2.27
8	27	M	3.78	4.21	4.01	3.72	3.71
9	20	F	2.53	2.73	2.62	2.48	2.44
10	56	M	2.82	2.92	2.71	2.63	2.64
11	19	F	2.45	2.81	2.65	2.48	2.44
12	19	F	2.42	2.73	2.62	2.45	2.39
13	30	M	3.34	3.51	3.39	3.06	2.92
14	47	F	2.48	2.59	2.41	2.22	2.21

S.NO	AGE	SEX	Probing Pocket Depth				
			Baseline	3 Months	6 Months	9 Months	12 Months
1	35	M	1.5	2	2	3	3
2	35	M	1.5	2	2.5	2.5	3
3	22	M	1	1.5	2.5	2.5	3
4	42	F	1.5	2	2	2.5	2.5
5	52	M	1.5	2	2.5	2.5	3
6	52	M	1	2	2	2.5	3
7	42	F	1	1.5	2	2.5	2.5
8	27	M	1	1.5	2	2.5	2.5
9	20	F	1	1.5	1.5	2	2.5
10	56	M	1.5	1.5	2	2.5	3
11	19	F	1	1.5	1.5	2	2.5
12	19	F	1.5	2	2	2.5	2.5
13	30	M	1	1.5	2	2	2.5
14	47	F	1.5	2	2.5	2.5	3

S.NO	AGE	SEX	Mesial Horizontal Bone Loss			Mesial Vertical Bone Loss		
			Baseline	3months	12months	Baseline	3months	12months
1	35	M	0	1.7	0.9	0.2	1.2	0.7
2	35	M	0	1.8	0.8	0.2	1.2	0.9
3	22	M	0.4	1.7	1.4	0.2	0.8	0.4
4	42	F	0.3	1.7	0.9	0.4	1.6	1.2
5	52	M	0.2	1.8	0.9	0.4	2.3	1.2
6	52	M	0.5	2.7	1.8	0.4	2.2	1.5
7	42	F	0	0.8	0.6	0	0.7	0.7
8	27	M	0	0.8	0.6	0.2	1.1	0.7
9	20	F	0.3	1.2	0.8	0.2	1.4	0.9
10	56	M	0	1.2	0.7	0.2	1.6	0.9
11	19	F	0.4	2.7	1.8	0.5	2.4	1.8
12	19	F	0.5	2.2	1.9	0.3	1.2	0.9
13	30	M	0.4	1.2	1.5	0.2	0.6	1.4
14	47	F	0.4	2.1	1.2	0.3	1.9	1.5

S.NO	AGE	SEX	Distal Horizontal Bone Loss			Distal Vertical Bone Loss		
			Baseline	3months	12months	Baseline	3months	12months
1	35	M	0.4	1.1	0.9	0.2	1.1	0.6
2	35	M	0	1.2	0.7	0.1	0.8	0.6
3	22	M	0.3	1.2	0.9	0	1.1	0.6
4	42	F	0.4	1.8	1.4	0.2	1	0.8
5	52	M	0.3	2.1	1.5	0.4	1.8	1.4
6	52	M	0.2	2	1.6	0.3	1.4	1
7	42	F	0.2	1.2	0.9	0	1.3	0.7
8	27	M	0.2	1.2	0.8	0.2	1.3	0.9
9	20	F	0	0.8	0.6	0.2	1.1	0.9
10	56	M	0	1.1	0.9	0.3	1.3	0.9
11	19	F	0.4	1.8	1.6	0.2	1.9	1.2
12	19	F	0.2	1.7	1.2	0	0.6	0.3
13	30	M	0.2	0.7	1.2	0.1	0.4	0.9
14	47	F	0.4	1.6	1.2	0.2	1.7	1.1

S.NO	AGE	SEX	Buccal bone loss			Lingual bone loss		
			Baseline	3months	12months	Baseline	3months	12months
1	35	M	0	0	0.4	0	0	0.3
2	35	M	0	0	0	0	0	0
3	22	M	0	0	0	0	0	0
4	42	F	0	0	0	0	0.2	0
5	52	M	0	0.8	0.6	0	0	0
6	52	M	0	0	0	0.1	0.4	0.3
7	42	F	0.4	0.4	0.8	0	0.2	0.4
8	27	M	0	0.4	0.2	0	0	0
9	20	F	0	0.6	0.4	0	0.7	0.3
10	56	M	0.2	0.9	0.6	0.2	0.5	0.4
11	19	F	0	0	0	0.1	0.3	0.3
12	19	F	0	0	0	0	0.2	0.2
13	30	M	0	0.5	0.2	0	0	0
14	47	F	0.2	0.9	0.8	0	0	0